FACTORS INFLUENCING SHIP REPAIR PART CONSUMPTION

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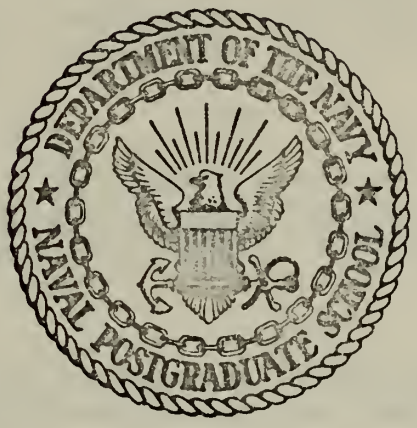

THESIS

FACTORS INFLUENCING SHIP REPAIR
PART CONSUMPTION

by

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Factors Influencing

Ship Repair Part Consumption

by

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ABSTRACT

An investigation was made of possible linear relationships between several specific factors concerning ships of the Navy and the actual repair part consumption dollar figures for a two year period for the purpose of using such relationships for planning and budgetary aids. Factors considered included steaming hours, fuel consumption, overhaul schedules and overhaul mandays, and ship age. Overall Navy-wide linear models were developed for NSA (odd cog) stock numbered items, for APA (even cog) stock numbered items, for Other (odd cog) manufacturer's part-numbered items (items without a Federal Stock Number assigned), and for a combined overall repair part model. In addition, some of the same models were developed for the Pacific and Atlantic fleets and for certain ship types.

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TABLE OF SYMBOLS AND ABBREVIATIONS

RPC	Repair Part consumption, dollars consumed.
NSA	Navy Stock Account (odd cognizance classes) Federal Stock Numbered items; the Navy Stock Account is financed by the Navy Stock Fund, a working capital or revolving fund whose capital to acquire replacement stock is provided by reimbursement for all issues to the customer from the Operation and Maintenance appropriation funds in the hands of the consumer.
APA	Appropriations Purchases Account (even cognizance classes) of Federal Stock Numbered items; APA consists of the following appropriations: Procurement of Aircraft and Missiles, Navy (PAMN), used to acquire aircraft, aircraft engines, various missiles, certain high value spares and repair parts, and related support equipment and facilities; Ship Construction and Conversion, Navy (SCN), which pays for the construction and initial outfitting of new ships and major conversion and outfitting of ships already completed; and Other Procurement, Navy (OPN), which consists essentially of high value ship spares and repair parts, convential ammunition, nuclear weapons, and materials handling equipment.
OTHER	(Odd cognizance classes) manufacturer's part-numbered items (items that have not been assigned a Federal Stock Number); these repair parts are funded by the Navy Stock Fund.
OVERALL COMBINED	Combined NSA, APA, and OTHER items.
AGE	Ship age, in months, from the month of commissioning.
TSLOH	Time, in months, since the last overhaul.
SHIN	Steaming hours in port, monthly.
LMSHIN	Previous month's steaming hours in port.
SHUW	Steaming hours underway, monthly.
LMSHUW	Previous month's steaming hours underway.
FCIN	Fuel consumption in port, monthly, gallons consumed.

LMFCIN	Previous month's fuel consumption in port.
FCUW	Fuel consumption underway, monthly, gallons consumed.
LMFCUW	Previous month's fuel consumption underway.
TOTMDY	Total mandays expended during the last overhaul.
RMDY	Repair mandays expended during last overhaul.
SMDY	Ship and Facility Support (S&F) mandays expended during last overhaul.
TMDY	Ship Construction and Conversion (SCN) mandays expended during last overhaul.
UMDY	Ordnance mandays expended during last overhaul.
VMDY	Other mandays expended during last overhaul.
Y	The independent variable (RPC) in the models.
Y_*	The predicted RPC from the models using test data.
s^2	The unbiased estimate of the variance of a model.
X	The matrix of dependent variables in a model.
d_a	The disturbance for month a for any model.
e_a	The residual for month a for any model.
R^2	Coefficient of Determination; a measure of goodness of fit of the model.
w	A column matrix of the test data.
b	A column matrix of the constant and coefficients of a model.
t	The t-distribution.
n	The number of data points.
$()^{-1}$	The inverse of a matrix.
X'	The transpose of a matrix X.

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I. INTRODUCTION

For some time, Navy budget managers and operators have been concerned with the costs of supporting ships. Of particular concern is the consumption of repair parts; what factors most affect this consumption, and what are the repercussions of budget cuts in this area. Many managers generally feel that repair part consumption should be related to such things as ship age, time since last overhaul, and other operating factors of this nature. To the present time, however, no known studies have been made to either prove or disprove this hypothesis.

The object of this thesis was to develop linear models using least squares regression techniques to attempt to determine if repair part consumption was actually related to various operating factors. Linear models only were developed and no attempt was made to determine the "best" model to explain repair part consumption. This was done primarily to determine if simple linear models did exist which explained repair part consumption. Linear models are relatively simple to use and are easily understood by managers.

The models of this thesis were developed for possible use by Navy repair part managers as budgeting and planning aids for estimating consumption of NSA, APA, Other and Overall Combined repair part dollars. Monthly, quarterly, or yearly estimates of repair part consumption on a Navy-wide scale,

Pacific or Atlantic fleet scale or a certain ship type scale would be possible using models developed for this thesis. Repair part consumption models may possibly be used for planning inventory policies or estimating overhaul repair part consumption, but these uses were not investigated by this thesis.

In developing the models of this thesis, repair part consumption data in dollar figures as reported under the 3M system for a twenty-four month period (July 1970 through June 1972) for 474 ships were evaluated. Data for the same period and the same 474 ships concerning operating factors that might influence consumption were similarly evaluated. Factors evaluated included ship age, time since last overhaul, steaming hours in port and underway, fuel consumption in port and underway, mandays expended during the last overhaul, ship type, and Pacific and Atlantic fleets. Of the 474 ships, 326 ships remained for consideration after this initial evaluation phase. The others were eliminated from the study because of obvious inconsistencies in their reported data. Data concerning the operating factors for the same period were obtained from the Center for Naval Analysis, Washington, D.C. from overhaul departure reports, ships' logs, and other reports of the Navy system. A more detailed discussion of the data sources and data is contained in Appendix E.

In developing all the models of this thesis, the stepwise linear regression procedure as developed by the University of California at Los Angeles (UCLA), BIMEDO2R was

utilized (1). Step-wise linear regression, as accomplished by BIMEDO2R, considers all the variables to be included in a model and mathematically chooses the variable that is most important in explaining the variation of the data of a model. A coefficient is computed for that important variable and then the next most important variable is chosen. This process is continued until all variables have been considered or until the contribution of the next variable is not significant in explaining the remaining variation. BIMEDO2R allows computations of coefficients for variables with or without a constant term appearing in the model. The models of this thesis all include a constant term since it was decided to designate these constants as the "fixed portion" of repair part consumption. BIMEDO2R mathematically computes the standard deviations of the coefficients of the variables and calculates a test statistic for performing acceptance testing of the models. A 95% significance level t-test was used for testing significance of the coefficients in the models of this thesis. The models of this thesis are shown with the most important variables occurring first and those variables of lesser importance occurring later, as determined by the BIMEDO2R procedure. More detailed information concerning BIMEDO2R, the test statistics, and the mathematical computations involved in the procedure are contained in reference (1).

Section II of this thesis considers some assumptions about the repair part consumption data and contains the

factors used in the development of the models of the thesis and discusses the criteria used to allow inclusion into consideration for the data.

Models developed within the thesis include models for overall Navy-wide repair part consumption, for NSA (odd cog) stock numbered items, for APA (even cog) stock numbered items, and for Other part-numbered (odd cog items without a Federal Stock Number assigned) items. Additionally, models were developed for the four categories (Overall, NSA, APA, and Other) for the Pacific and Atlantic fleets, and for certain ship types. The models developed are discussed in Section III of the thesis.

The results and conclusions of the thesis are discussed in Section IV. Tests performed on the models and the results are contained in Appendixes A, B, and C. A listing of the ships considered in the models is included in Appendix D and the data used in the models is included in Appendix E. The COBOL computer programs to extract the required information from the master tape are included in Appendix F, and the COBOL computer programs to construct a master tape for use with the models are included in Appendixes G, H, and I. Appendix J contains the mathematics of prediction interval computations for the models.

II. DESCRIBING THE SYSTEM

A. MAJOR ASSUMPTIONS

The following major assumptions were made concerning the data received and evaluated and concerning the Navy reporting systems.

1. The reporting of repair part consumption to the Maintenance Support Office, Mechanicsburg was a requirement for all ships considered in the models of the thesis. Data received from MSO and CNA, Washington were assumed accurate and up-to-date, subject to the criteria contained in Part B of this section. Appendix H contains a more detailed discussion of the data and data sources.

2. The repair part consumption data were samples from an underlying normal distribution of consumption data. For each of the operating factors, data were also assumed to be samples from underlying normal distributions.

3. The figures for repair part consumption data for all models were independent random variables.

The assumptions of normality and of independent random variables for the repair part consumption data are required for the model development, test statistics, and prediction intervals of the models of the thesis.

B. PARAMETERS AND VARIABLES

The parameters and variables of this thesis consisted of those listed below. For each variable, the criterion used

for determining whether the reported data for a particular ship would be considered reliable so that the ship would be included in the models is shown in the listing as well. The parameters and variables were:

1. The dollar value of repair part consumption (RPC) for NSA, APA, Other (manufacturers' part-numbered items which have no Federal Stock Number assigned) and Overall Combined (the combined figures for NSA, APA, and Other). The figures obtained from MSO, Mechanicsburg were assumed correct and utilized if the operating data for the ship in question met the criteria for inclusion into the models. If, however, zeros were obtained as reported data from MSO for three successive months, the repair part consumption was assumed erroneous and the ship was excluded from consideration.

2. The age of the ship (AGE), in months, computed from the month of commissioning.

3. The time since the last overhaul (TSLOH) of the ship, in months. This variable was computed as follows:

a. The month following the end of the last overhaul was determined to be month "one" for computation of the time since last overhaul.

b. If the ship was actually in overhaul during any month, the time since last overhaul was computed by determining the months since the overhaul prior to the one the ship was now actively engaged in.

4. The steaming hours in port (SHIN) during the month under consideration. This variable was obtained by accepting

the figures contained in the data obtained from CNA, Washington if there existed data for both steaming hours in port and fuel consumption in port (FCIN), or zeros for both in which case the data was also assumed correct and acceptable.

5. The steaming hours underway (SHUW) during the month under consideration. This variable was obtained in a manner similar to that of steaming hours in port (SHIN).

6. The fuel consumption in port (FCIN) for the month under consideration. This variable was reported in gallons consumption data, as was fuel consumption underway for the month under consideration. This variable was obtained as follows:

a. If the steaming hours in port (SHIN) was other than zero and the reported fuel consumption was other than zero, or if both variables were reported as zero, then the data was accepted as correct.

b. If the fuel consumption in port (FCIN) data was reported as zero for four successive months and the ship was not actively engaged in an overhaul, the ship was excluded from consideration in the models.

7. The fuel consumption underway (FCUW) for the month under consideration. This variable was reported in gallon consumption data. This variable was obtained in a manner similar to that for fuel consumption in port (FCIN).

8. The total mandays (TOTMDY) expended during the last overhaul. Mandays during the last overhaul were reported in five categories (Repair, Ship and Facility Support (S&F),

Ship Conversion and Construction, Navy (SCN), Ordnance and Other) plus the combined total mandays expended figure. These figures were accepted as correct as obtained through reports provided by CNA, Washington. The total mandays expended (TOTMDY) figures were used in determination of the models instead of the five categories of mandays for reasons discussed in Section IIIA of this thesis.

9. The last month's steaming hours in port (LMSHIN). As discussed in Section III of the thesis, lagged variables were considered in the determination of the models. Lagged variables means that the previous month's data might have some effect on the prediction of the current month's repair part consumption. As shown in Section III, the only lagged variable that was significant in any model was the previous month's steaming hours in port. The data for this variable was obtained in a manner similar to that for the current month's steaming hours in port (SHIN).

The resulting data, which was used in estimating the models of Section III, consisted of 24 observations on each of the variables listed above - one observation for each of the 24 months in the data reporting period. The observation for a particular variable in a particular month was obtained by summing that variable over all ships included in the sample.

The parameters and variables listed above were those utilized in the determination of the models of this thesis. Much more detailed parameters and variables were reported by MSO and CNA, however. MSO reported dollar figure repair part

consumption data by NSA, APA, and Other as used in this thesis; also reported was the consumption within each of these categories by the two most important digits of the Equipment Identification Code (EIC) for the different types of equipment aboard each ship. CNA reported, in addition to those variables used in the thesis, the types of overhauls the ships underwent, the type commander of each ship, and several other more detailed categories of operating factors concerning each ship. These more detailed reportings were not used in the models of the thesis primarily because of the time involved in evaluating and utilizing such detailed information and, secondarily, it was the purpose of this thesis to attempt to find simple linear models that could be easily and readily used and understood. For these reasons, the more detailed categories of reported data were not considered in the determination of the models. Such detailed study may, however, be a profitable area of further research.

III. DEVELOPMENT OF MODELS

A. NAVY-WIDE MODELS

As a first attempt to determine linear models for repair part consumption the data available for all 474 ships was utilized without eliminating the cases of obviously poor data reporting as discussed in Section II of the thesis. The parameters for each month for all 474 ships were totaled. The summed total figures of the parameters for each month were used in the determination of models. These attempts failed to generate acceptable models for use. There was significant correlation among several of the variables, notably ship age (AGE) and repair part consumption (RPC), between ship age (AGE) and the time since last overhaul (TSLOH), between ship age (AGE) and the different categories of mandays expended in the last overhaul, and between the different categories of mandays expended. The models so attempted did not explain the variance of the models to any significant degree. The approach of using all data reported to determine models was abandoned.

The second approach was to eliminate obviously bad data utilizing the computations for the various parameters as listed in Section II of the thesis. For example, only those ships which had by the computation decisions of Section II, "good" APA reported repair part consumption were utilized in attempting to determine the Navy-wide APA model. Similarly,

for the NSA, Other and Overall Combined models, only "good" data was utilized. In each of the models, only those ships that met the computation criteria for fuel consumption and steaming hours were utilized in the models. After eliminating bad data, there remained a smaller number of ships to be used in determination of the models. Specifically, the numbers of ships to be used in each model were: Overall Combined: 126 ships; NSA: 251 ships; APA: 182 ships; and Other: 134 ships. As a result of these computations, the ships included in the models were all types of ships on which data was available with the exceptions of Aircraft Carriers (CVA) and Auxiliary Fast Support (AFS) ships. No ships in these classes of ships met the criteria for model inclusion. In particular, little or no repair part consumption data was available for any CVA or AFS.

Using this second approach, model determination was again attempted. Better results were obtained but again no significant acceptable models were generated. Again there was significant correlation between variables, largely between ship age (AGE) and the other variables. Determinations of the models then was attempted without using the variable of ship age (AGE). The reasons for this approach were that ship age (AGE), computed as the sum of the ages of all the ships in a model, seemed to create the correlation problems and to cause the models to be unacceptable since, in the step-wise linear regressions used, ship age (AGE) entered the model as the first variable in all cases and caused the models to "blow-up". That is, no other variable could enter in a

significant manner and the ship age variable by itself did not adequately explain the variances of the models. It was reasoned that the computation of ship age as being the total number of months since commissioning date may have been an erroneous computation. The reasoning was that many, if not most, of the older ships commissioned prior to 1960, which was a significant portion of the 474 ships on which data was available, had undergone some sort of conversion or updating since 1960. An example would be the FRAM (Fleet Rehabilitation and Modernization) conversions of most of the older destroyer type ships. Because of the conversions and/or updating of equipment aboard the ships, the question arose as to how to acceptably compute the "age" of a ship. Several possible alternative computations were proposed, but none was acceptable in that all entailed such arbitrary decisions as had been originally made. Defining the variable ship age (AGE) to be the sum of the ages of all ships in a model seemed to contribute to the problem area as well. In addition, ship age (AGE), as computed, did not allow Navy managers much control over that variable. It was desired that models be developed with variables that allowed some control by managers. For these reasons, the variable ship age (AGE) was abandoned as one of the variables for consideration in the models. In addition, because of the high correlations among the different manday categories, it was decided to use only the total mandays expended during the last overhaul (TOTMDY) figures in the models and abandon the sub-classifications of overhaul mandays as variables for consideration.

As stated above, determination of the models without the variable ship age (AGE) was then attempted. The use of lagged variables and a variable to account for trend effects (i.e., inflation) was made. Lagged variables means the use of the previous month's fuel consumption in port (LMFCIN), fuel consumption underway (LMFCUW), steaming hours in port (LMSHIN), and steaming hours underway (LMSHUW) to determine if any of these previous month's variables contributed to explanation of the variance of the model. A "time" variable, computed as the number of months since the beginning of the reported data period, was used to account for any trend effects in the models. This variable of "time" was forced to be an addition to the model; the variable was not allowed to enter as a free variable. The purpose of this approach was to determine if any additional variance of the model could be explained by trend effects in the data. The models generated by this approach are discussed below.

1. Discussion of the Models

In the models developed, the only lagged variable that entered into any model was the previous month's steaming hours in port (LMSHIN) which entered into the OVERALL COMBINED model. The variable "time" did not enter, at a 95% significance level, into any model. The conclusion was therefore reached that there existed no trend effect, due to inflation or otherwise, in any of the models. A Coefficient of Determination, R^2, which is a measure of the goodness of fit of the models to the data that shows the proportion of

the variance of the repair part consumption data explained by the model, was computed for each model. These ranged from 0.5251 through 0.7901; that is, from one-half to eighty percent of the variance of the data was explained, depending on the model. The models all contained a computed constant figure in addition to the variables in the models. These constants were interpreted as the "fixed cost" of supporting the ships of the models in the particular type of repair part consumption the model represented. These "fixed costs" did, however, have a range of values - that is, a standard deviation for each was computed - and therefore were not strictly constants. These "fixed costs" may be affected by variables not considered in the models.

For each coefficient for each variable of all the models, standard deviations for the coefficients were calculated and are included in the models. These standard deviations are shown in parentheses directly below the coefficients of the models.

For each model, the last three months of the 24 months of data (for months April through June 1972) were not used in the development of the models but were used as test figures to test the predictive powers of the models. Problems arose with this procedure since, for unexplained reasons, the last two months' (May and June 1972) data was of an outlying nature. That is, May's data was significantly lower than normal and June's data was significantly higher than normal. The range of these two months' data was significantly

outside that of the other twenty-two months' data used in the thesis. As will be discussed in Section IV of this thesis, it is recommended that the models of this thesis not be used to predict monthly repair part consumption since the range of possible predictions is too large, but instead to use the models for quarterly prediction purposes since the range of average quarterly figures is much less than monthly ranges of consumption data. In addition, money is allocated for expenditure on a quarterly basis vice a monthly basis, so that monthly predicted figures are not as necessary as quarterly average predictive figures to Navy managers. For these reasons, the average monthly repair part consumption for the last three months of the 24 month data period is predicted using the models of the thesis. The average quarterly figure is obtained by multiplying the average monthly predicted figure by three. The average monthly predicted repair part consumptions were computed as follows: (1) the predicted monthly consumption for each of the three months was calculated using the data observations in the models for each of the three months; and (2) the average monthly repair part consumption for the quarter was computed as one-third the sum of the three monthly predictions. Additionally, for informational purposes, the reported repair part consumption for each of three months was averaged to obtain the reported average monthly repair part consumption for the quarter. A 95% prediction interval was computed for the average monthly repair part consumption. Appendix J contains the mathematical

computations required to obtain these prediction intervals. These mathematical computations were based on procedures contained in reference (3). The range of prediction interval as a percentage of the predicted average monthly consumption was computed for each model. The results for all the models are contained in the Brief Summary of Models table in Section IV of this thesis.

It will be noted that two of the models' reported average repair part consumption did not fall within the prediction intervals for those models. These models were the Ship Type - Cruiser Overall Combined model and the Ship Type - Cruiser NSA model. It was felt that this was caused by (1) the fact that the R^2 of the Ship Type - Cruiser NSA model was 0.1962 - that is, the model was not a good prediction model - caused the reported average repair part consumption to fall outside the prediction interval for that model; and (2) the problem of the Cruiser NSA model carried over to the Cruiser Overall Combined model since exactly the same ships were included in the two models.

The acceptable variables entering the Navy-wide models were not fully consistent from model to model but some consistency was found in that the total mandays expended during the last overhaul (TOTMDY) entered as the most significant variable in three of the models, in that the time since last overhaul (TSLOH) entered two of the four models, and in that fuel consumption and/or steaming hours entered into all four models in some way. The models and the computed data for each

model are listed below with some observations made concerning each of the models. As previously mentioned, a table containing a summary brief of all the models is contained in Section IV of the thesis.

a. Overall Combined Model

Model: $Y = 373{,}114{,}141 + 7.0(FCUW) - 6788.9(LMSHIN)$
(40526) (1.3) (1923)

Incremental Increase
In and Total R^2: (0.3874) + (0.2507) = 0.6381

Test quarter average reported consumption: $430.74 million

Predicted average monthly consumption: $458.40 million

95% Prediction Inverval: ($427.69 million, $489.11 million)

PI as % of predicted consumption: 13.4%

Number of ships considered in the model: 126

Observations: Fuel consumption underway (FCUW) explained almost 39% of the variance of the model while the previous month's steaming hours in port explained an additional 25% of the variance. A causation statement implied by the model is that cost reductions might be obtained by decreasing the time spent at sea and increasing the time spent in port by the ships. While this may be an obvious statement, the feasibility of doing that is questionable. A caution is made that the statements made in the observations above, and those made in the observation sections of the following models, imply causation while, in fact, only correlation is observed.

b. NSA Model

Model: $Y = 367{,}875{,}078 - 16.3(TOTMDY) + 5.1(FCIN)$
(58108) (4.5) (2.4)

Incremental Increase
In and Total R^2: (0.4394) + (0.0857) = 0.5251

Test quarter average reported consumption: $241.87 million

Predicted average monthly consumption: $220.76 million

95% Prediction Interval: ($196.15 million, $245.37 million)

PI as % of predicted consumption: 22.3%

Number of ships considered in the model: 251

Observations: Only about one-half of the variance of the model is explained by the variables, and total mandays expended explains almost 44% by itself. A causation statement implied by the model is that cost reductions may be gained by increasing the number of mandays expended during overhauls, and decreasing fuel consumption in port. Whether doing so will actually lead to cost reductions depends on the relative cost of NSA material and mandays, so that increasing mandays may lead to more cost instead of less cost.

c. APA Model

Model:

$Y = 438{,}912{,}344 - 53.0(TOTMDY) + 2117.6(SHUW) + 72564.8(TSLOH)$
(36213) (8.5) (849) (33718)

Incremental Increase
In and Total R^2: (0.6726) + (0.0603) + (0.0572) = 0.7901

Test quarter average reported consumption: $312.61 million

Predicted average monthly consumption: $321.61 million

95% Prediction Interval: ($306.32 million, $336.90 million)

PI as % of predicted consumption: 9.5%

Number of ships considered in the model: 182

Observations: Of the 79% of the variance explained, total mandays expended during the last overhaul explains 67% by itself. This may be partly explained by the fact that APA material of high value is usually installed on board ships during overhaul. Not all APA material is installed in overhaul, obviously, but a high percentage is installed then. A causation statement implied by the model is that increasing the mandays expended in overhaul, decreasing the length of time between overhauls, and decreasing steaming hours underway might lead to cost reductions in repair part consumption. Such a statement is not unexpected, but whether such a schedule could be followed is highly questionable.

d. Other model

Model:

$$Y = \underset{(30671)}{130{,}772{,}813} - \underset{(4.3)}{9.9}(TOTMDY) + \underset{(1.3)}{4.8}(FCIN) - \underset{(381)}{1522.5}(SHIN) - \underset{(9144)}{20807.3}(TSLOH)$$

Incremental Increase
In and Total R^2: (0.1605) + (0.0946) + (0.2561) + (.1195)

= 0.6307

Test quarter average reported consumption: $17.64 million

Predicted average monthly consumption: $14.87 million

95% Prediction Interval: ($12.06 million, $17.68 million)

PI as % of predicted consumption: 37.8%

Number of ships considered in the model: 134

Observations: While 63% of the variance is explained in the model, no one variable explains a majority of the variance that is explained. This fact may possibly be because of the nature of the items (manufacturers' part-numbered items without a Federal Stock Number assigned) contained in the model. These items may appear in very old equipment or in very new equipment, which may have just been installed during the last overhaul. In any case, a causation statement implied by this model is very similar to the statements of the other models - cost reductions may be gained by increasing the mandays expended during an overhaul, and decreasing fuel consumption. Logical inconsistencies seem to be in the model in that it is also implied that cost reductions may be gained by increasing steaming hours in port (and decreasing fuel consumption in port) and by increasing the time since last overhaul. No explanations are readily available for these inconsistencies.

B. "OCEAN" MODELS

After development of the Navy-wide models, it was decided to attempt to develop similar models for the Pacific and Atlantic fleets. Consequently, the ships for which data was available were segregated into Pacific and Atlantic fleets. The criteria for inclusion in the models was exactly the same as outlined for the Navy-wide models. The data computation criteria were similarly exactly the same as for the Navy-wide models. Since, in development of the Navy-wide models, time and ship age variables had been rejected from consideration, these variables were again rejected from consideration. An attempt was made to develop the models for the Pacific and Atlantic fleets using only the variables that were considered for the Navy-wide models. A secondary objective for developing the "ocean" models was to determine if the different operating characteristics and make-up of the Pacific and Atlantic fleets had any effect on repair part consumption.

Utilizing the same procedure for development of the models as outlined for the Navy-wide models, the "ocean" models were developed. The Overall Combined models were developed for use by the respective fleet managers. The results obtained for each model, the R^2 computed, and the other statistics associated with the models are included in the Brief Summary of Models table included in Section IV of this thesis. The models as developed will not be listed individually in this section. Discussion of the models and the observations/conclusions reached are shown below.

Discussion of "Ocean" Models

Acceptable models could not be developed for each of the four categories for each fleet. Specifically, models with significant variables to explain the data variance did not exist for Pacific Fleet NSA and for Atlantic Fleet Overall Combined categories. Models were developed for all the other categories for each fleet, however. The models developed had R^2 associated with them ranging from 0.37 through 0.836, so that, in some cases, most of the data variance was explained by the models. In all cases where models were developed, the actual last quarter's average consumption figure was included in the confidence intervals computed for the predicted figures. As can be seen from the models, fuel consumption underway (FCUW) and in port (FCIN) is the most important significant variable in the Pacific Fleet models while total mandays expended (TOTMDY) in overhaul is the most important significant variable in the Atlantic Fleet models. Fuel consumption and steaming hours are secondary significant variables in Atlantic Fleet models while the total mandays expended in overhaul variable is secondarily significant in the Pacific Fleet models. Whether these differences are explained by the different operating policies of the fleets (Viet-Nam versus the Mediterranean) or the much larger area of ocean covered by the Pacific Fleets than by the Atlantic Fleet is debatable.

In sum, some models did exist for the different categories of models for the Pacific and Atlantic Fleets. These

models were different in major significant variables which may be partly explained by the differences in the operating policies and operating areas of the respective fleets. In general, the models developed for the separate fleets were less efficient than the Navy-wide models in explaining the data disturbances.

C. SHIP TYPE MODELS

It was decided to attempt to develop models for the four categories of models (Overall Combined, NSA, APA, and Other) for different types of ships. The objectives of this approach were (1) to determine if such models did exist which might be of use to Navy managers (including type commanders) and (2) to determine if the type of ship in itself was an important variable in explaining repair part consumption. As with the "Ocean" models, the same criteria for inclusion into the models and computation of data criteria as for the Navy-wide models was used.

Ship types decided upon to be used were:

1. Destroyer types, which included ships classed as DD, DDG, DLG, DEG, DE and DLGN.

2. Cruiser types, which included CG, CGN and CLG.

3. Submarine types, which included ships classed as SS, SSN, and SSBN.

4. Amphibious types, which included ships classed as LSD, LPD, LPH, and LST.

5. Underway Replenishment types, which included ships classed as AF, AO, AOG, AOE, and AE.

Models were developed for the majority of the categories of models for each type of ship listed above, with the exception of the Underway Replenishment types. No models with significant variables existed for Underway Replenishment types, possibly because of the small number of ships included in the models or possibly because of the diversity of classes of ships included in this classification of ship types. Some other models did not exist for the other ship types classifications as well, notably, "Other" models existed only for the destroyer ship types. The results obtained for each model, the R^2 computed, and the other statistics associated with the models are included in the Brief Summary of Models table included in Section IV of this thesis and are not listed individually in this section. Discussion of the models and observations reached are shown below.

Discussion of Ship Type Models

Although several models were developed for the different ship types, the range of R^2 of the models was from 0.1962 to 0.5655, so that, in general, the majority of the models did not explain well the variances of the consumption data. Some of the models are questionable as to acceptability because of this fact.

The important variables for the ship type models did vary according to ship type, indicating that the type of ship under consideration is an important variable in itself. Specifically, the most important variable for the destroyer type models was fuel consumption underway (FCUW); for the

cruisers, in general, the most important variable was the total mandays expended (TOTMDY) during the last overhaul; for submarines each model had a different most important variable including steaming hours underway (SHUW) total mandays expended (TOTMDY) last overhaul, and fuel consumption in port (FCIN), depending on the model under consideration; for amphibious types the important variables were again different for each model and included fuel consumption underway (FCUW), steaming hours underway (SHUW), and total mandays expended (TOTMDY) last overhaul. As previously noted, no models existed for the Underway Replenishment classification of ship types.

In sum, models of questionable acceptability existed for all the ship types (except Underway Replenishment types) in all categories of models except Other. In general, fuel consumption and total mandays expended (TOTMDY) last overhaul were the most important variables of the models, with other variables important in specific models or of secondary importance to the models. However, the important variables in the models did differ from ship type to ship type leading to the possibility that ship type in itself may be an important variable in explaining repair part consumption.

IV. RESULTS, CONCLUSIONS AND RECOMMENDATIONS

The results of this thesis were the development of linear prediction models for repair part consumption in each of four categories of parts (Overall Combined, NSA, APA, and Other). Models were developed for Navy-wide repair part consumption, for Pacific and Atlantic fleet repair part consumption, and for different ship types repair part consumption. Although significant models did not exist for all categories in each case, notably the category of Other for some of the ship types models, and the goodness of fit of some of the models developed was of questionable acceptibility, it is felt that the purpose of the thesis, which was to determine if repair part consumption was linearly related to various operating factors, has been fulfilled. Sufficient acceptable models were developed to enable the conclusion to be drawn that repair part consumption is linearly related to various operating factors. The inclusion into the models of additional operating factors such as a variable that adequately measures the age of a ship, or a variable that enters into consideration the political climate of the world, such as a dummy variable for Vietnam service, may increase the goodness of fit of the models developed. In addition, the models and data may be subdivided into Equipment Identification Codes and linear models possibly developed for each EIC. These are areas into which further research can be done.

The models developed within this thesis, the R^2 of each, the test quarter's actual average repair part consumption, the predicted consumption, a 95% confidence interval for each prediction, and the confidence interval of each prediction expressed as a percentage of the predicted consumption are shown in the following Brief Summary of Models table.

BRIEF SUMMARY OF MODELS

Model Type	Model (with standard deviations of coefficients in parenthesis)	# of Ships in Model	R^2	Test Data RPC (millions)	Predicted RPC (millions)	Prediction Interval (millions)	PI as % of Predicted
NAVY-WIDE MODELS							
OVERALL COMBINED	373,114,141 + 7(FCUW) (40526 (1.3) - 6788.9(LMSHIN) (1923)	126	.6381	430.74	458.40	(427.69, 489.11)	13.4
NSA	367,875,078 - 16.3(TOTMDY) (58108) (4.5) + 5.1(FCIN) (2.4)	251	.5251	241.87	220.76	(196.15, 245.37)	22.3
APA	438,912,344 - 53(TOTMDY) (36213) (8.5) + 2117.6(SHUW) + 72564.8(TSLOH) (849) (33718)	182	.7901	312.61	321.61	(306.32, 336.90)	9.5
OTHER	130,772,813 - 9.9(TOTMDY) (30671) (4.3) + 4.8(FCIN) - 1522.5(SHIN) (1.3) (381) - 20807.3(TSLOH) (9144)	134	.6307	17.64	14.87	(12.06, 17.68)	37.8

Model Type	Model (with standard deviations of coefficients in parenthesis)	# of Ships in Model	R^2	Test Data RPC (millions)	Predicted RPC (millions)	Prediction Interval (millions)	PI as % of Predicted
PACIFIC OCEAN MODELS							
OVERALL COMBINED	66,748,945 + 5.9(FCUW) (2452) (1.8) - 21.3(FCIN) (8.9)	31	.3703	92.26	94.99	(82.09, 107.89)	27.2
NSA	No model with significant variables	81	-	53.73	-	-	-
APA	54,195,234 + 3.5(FCUW) (1475) (1.0) - 17.2(FCIN) (5.8)	49	.4031	69.79	71.70	(62.16, 81.24)	26.6
OTHER	- 2,497,588 + 8.9(TOTMDY) (1406) (2.1)	32	.4816	4.08	4.21	(3.34, 5.08)	41.3
ATLANTIC OCEAN MODELS							
OVERALL COMBINED	No model with significant variables	170	-	338.48	-	-	-

Model Type	Model (with standard deviations of coefficients in parenthesis)	# of Ships in Model	R^2	Test Data RPC (millions)	Predicted RPC (millions	Prediction Interval (millions)	PI as % of Predicted
ATLANTIC OCEAN MODELS Cont'd							
NSA	361,752,852 - 23.5(TOTMDY) (43911) (4.5) + 6.0(FCIN) (2.6)	95	.6344	188.13	178.71	(162.98, 194.44)	17.6
APA	- 55,439,023 - 40.6(TOTMDY (5837) (5.1) + 4961.7(SHIN) + 163118.6(TSLOH) (1288) (45289)	162	.8360	292.77	294.53	(287.46, 301.60)	4.8
OTHER	71,882,422 - 10.8(TOTMDY) (2653) (1.7)	125	.6857	17.23	19.40	(14.56, 24.24)	49.9
SHIP TYPE - DESTROYERS							
OVERALL COMBINED	202,196,289 + 5.1(FCUW) (7861) (1.7)	89	.3279	320.29	309.03	(247.90, 370.16)	42.8
NSA	89,846,523 + 1.4(FCUW) (2923) (0.6)	98	.2311	124.61	120.89	(97.80, 143.98)	38.2

Model Type	Model (with standard deviations of coefficients in parenthesis)	# of Ships in Model	R^2	Test Data RPC (millions)	Predicted RPC (millions)	Prediction Interval (millions)	PI as % of Predicted
SHIP TYPE - DESTROYERS Cont'd							
APA	149,245,625 + 4.6(FCUW) (8022) (1.1) - 4012.0(SHIN) (1842)	98	.4870	196.75	206.32	(177.44, 235.20)	28.0
OTHER	89,889,180 - 35(TOTMDY) (4937) (7.0)	89	.5655	12.00	11.08	(10.14, 12.02)	16.9
SHIP TYPE - CRUISERS							
OVERALL COMBINED	14,782,617 + 30(TOTMDY) (2276) (9.2) + 5956.2(SHIN) (2657)	7	.4970	58.91	46.63	(36.00, 57.26)	45.6
NSA	13,361,260 + 2128.6(SHIN) (6084) (989)	7	.1962	21.89	16.12	(12.71, 19.53	42.3
APA	5,009,605 + 32.1(TOTMDY) (4443) (7.0)	7	.5216	34.41	30.84	(26.49, 35.19)	28.2

Model Type	Model (with standard deviations of coefficients in parenthesis)	# of Ships in Model	R^2	Test Data RPC (millions)	Predicted RPC (millions)	Prediction Interval (millions)	PI as % of Predicted
SHIP TYPE - CRUISERS Cont'd							
OTHER	No model with significant variables	7	-	2.61	-	-	-
SHIP TYPE - SUBMARINES							
OVERALL COMBINED	29,489,973 - 4914.3(SHUW) (3661) (1502) + 1623.9(FCIN) (517)	5	.5217	20.25	20.39	(14.59, 26.19)	56.9
NSA	98,536,992 - 6.1(TOTMDY) (4974) (2.3)	55	.2793	62.54	60.37	(51.44, 69.30)	29.6
APA	68,265,078 - 367.6(FCIN) (6325) (142.5) - 9.3(TOTMDY) + 43229.6(TSLOH) (3.2) (20834)	45	.5459	64.12	65.25	(57.03, 73.47)	25.2
OTHER	No model with significant variables	5	-	0.22	-	-	-

Model Type	Model (with standard deviations of coefficients in parenthesis)	# of Ships in Model	R^2	Test Data RPC (millions)	Predicted RPC (millions)	Prediction Interval (millions)	PI as % of Predicted
SHIP TYPE - AMPHIBIOUS							
OVERALL COMBINED	1,040,581 + 3.3(FCUW) (1810) (1.3) + 51820.6(TSLOH) (22888)	13	.3907	20.98	23.98	(17.93, 30.03)	50.5
NSA	4,788,611 + 1777(SHUW) (2006) (587)	18	.3257	12.38	11.79	(9.99, 13.59)	30.5
APA	5,616,633 - 9.7(TOTMDY) (1694) (4.1) + 35788.9(TSLOH) (15924)	16	.5145	10.92	14.62	(11.11, 18.13)	48.0
OTHER	No model with significant variables	13	-	1.10	-	-	-
SHIP TYPE - UNDERWAY REPLENISHMENT							
OVERALL COMBINED	No model with significant variables	10	-	9.09	-	-	-
NSA	No model with significant variables	18	-	7.78	-	-	-

Model Type	Model (with standard deviations of coefficients in prenthesis)	# of Ships in Model	R^2	Test Data RPC (millions)	Predicted RPC (millions)	Prediction Interval (millions)	PI as % of Predicted
SHIP TYPE - UNDERWAY REPLENISHMENT Cont'd							
APA	No model with significant variables	12	-	4.58	-	-	-
OTHER	No model with significant variables	12	-	0.69	-	-	-

Conclusions that can be drawn from this thesis and from inspection of the models developed include:

1. Repair part consumption dollar figures are linearly related to various operating factors such as overhaul schedules, fuel consumption, and steaming hours. In addition, repair part consumption is linearly related to ship age, but ship age was eliminated from consideration because of being a variable that is uncontrollable by Navy managers.

2. Of the variables considered in this thesis, overhaul schedules - that is, the mandays expended (TOMDY) during overhauls and the duration between overhauls (TSLOH) - appear to be the dominant variables in many of the models developed. Fuel consumption and steaming hours, both in port and underway, are important to most models and dominant in some of the models, notable the ship type models.

3. Several of the models developed are of questionable acceptability in that the models do not adequately explain the variances of the data within the models. Inclusion of additional factors or a larger sampling of data for those variables considered might alleviate this inadequacy.

4. The models, as developed, may be used for predictions of monthly repair part consumption for the four categories (Combined Overall, NSA, APA, and Other) of models. Fairly good results can be obtained for the Navy-wide models and several of the sub-models. It is recommended, however, that if the models are used for prediction, the predictions be for at least a quarterly period. The reasons for this recommendation

are (1) that Navy managers allocate expenditures on a quarterly basis, (2) monthly repair part consumption varies more rapidly from month to month than from quarter to quarter, and (3) therefore, predictions on a quarterly basis would tend to be more realistic and accurate.

5. In the models of the thesis, the signs (positive or negative) of the coefficients of the significant variables imply some causation statements concerning the possibility of cost reductions and savings. The statements, it is cautioned, imply causation while, in fact, only correlation is observed in the models. The statements are:

a. The negative sign of the variable mandays expended during last overhaul (TOTMDY) in the majority of cases where that variable significantly entered the models implies that cost reduction in repair part consumption might be obtained by increasing the length of and mandays expended during overhauls. While this may seem an obvious statement, the increased cost of longer overhauls may outweigh any cost reductions so obtained.

b. The positive sign of the variable time since last overhaul (TSLOH) in the models in which that variable significantly entered implies cost reductions might be obtained by decreasing the time between overhauls. This is another unsurprising statement, but, as before, the increased cost of more frequent overhauls may outweigh any cost reductions realized in repair part consumption.

c. In general, fuel consumption underway (FCUW) had positive signs for the coefficients, and fuel consumption in port (FCIN) had a negative sign for the coefficients. In a related manner, the variable steaming hours underway (SHUW) had, in the majority of models significantly entered, a positive sign; steaming hours in port (SHIN) had, in the majority a negative sign. These results imply a statement that decreasing the time spent at sea and increasing the time spent in port by ships may lead to cost reductions in repair part consumption. The statement may be an obvious one, but Navy operating policies and/or missions or the world political climate may not allow such scheduling.

In summary, the variables significantly entering the models did, in the majority of the models, enter with the sign of the coefficients the logically expected one, whether it be positive or negative. There were, in general, no major or unexpected surprises in the signs of the coefficients of the significant variables of the models.

Recommendations for use of the models of this thesis and for further research into the linearity of repair part consumption to various operating factors include:

1. As previously noted, it is recommended that the models of this thesis, if used, be used to predict quarterly consumption instead of monthly consumption, for the reasons noted.

2. The models of this thesis can be used for planning and budgetary aids, if desired. It is recommended that if the models be used, they be used as a check and/or test of

figures and estimates of budgetary requests or planned allocations of expenditures which were arrived at by the present methods of Navy managers. The models may, however, be used to arrive at estimates or predictions by the Navy managers. Such estimates or predictions would be liable to large variations if the present models were used.

3. It is recommended that the models be updated prior to use for periods later than June 1972 because of the possible changes in Navy operating policies, world political climate, Navy size and composition, and/or other possible changes from the 1970-1972 time period.

4. Areas for further research include, as previously noted, the addition of more variables (such as an adequate measure of the age of a ship) into the models to try to increase the goodness of fit and predictive powers of the models. A second approach for further research might be the subdivision of the present models into Equipment Identification Codes (EIC) and the development of possible linear models for each EIC. A final recommendation for further research is the gathering of more data for more ships in an effort to improve the predictive powers of the present models. This thesis covered only a two year period and some of the models of the thesis were developed considering only a small number of ships (five in one model, seven in another three models). The inclusion of more ships and for a longer period of time may lead to improvements in the current models.

APPENDIX A

CONSTANT VARIANCE (HETEROSCEDASTICITY) TEST AND RESULTS

The models of this thesis were tested under the null hypothesis that the variances of the disturbances were constant over time, with the alternative hypothesis that the variances of the disturbances either increased or decreased over time. The observations were divided into two equal groups of ten months in each group with the eleventh month of the twenty-one observations ignored. Then the least squares residuals were computed for both sets of observations separately. The residual sums of squares for the two sets of observations are independent and similarly distributed. The ratio of the sums of squares of the sets of observations was formed as a test statistic. This ratio is distributed as F(10-K, 10-K) under the null hypothesis. The ratio was compared to the five-percent significance level for the appropriate F distribution. The critical values of the F distributions, the computed test statistics, and the test results are listed below for the models of this thesis. A more detailed explanation of the procedure is contained in reference (3).

Model	F Critical Value	Test Statistic	Results
NAVY-WIDE MODELS			
OVERALL COMBINED	3.79	0.46	Accept hypothesis
NSA	3.79	0.30	Accept

Model	F Critical Value	Test Statistic	Results
NAVY-WIDE MODELS Cont'd			
APA	4.28	0.23	Accept
OTHER	5.05	1.10	Accept
PACIFIC OCEAN MODELS			
OVERALL COMBINED	3.79	0.21	Accept
NSA	-	-	-
APA	3.79	0.37	Accept
OTHER	3.44	0.76	Accept
ATLANTIC OCEAN MODELS			
OVERALL COMBINED	-	-	-
NSA	3.79	0.42	Accept
APA	4.28	0.28	Accept
OTHER	3.44	0.15	Accept
SHIP TYPES - DESTROYERS			
OVERALL COMBINED	3.44	0.39	Accept
NSA	3.44	0.51	Accept
APA	3.79	0.24	Accept
OTHER	3.44	0.98	Accept
SHIP TYPES - CRUISERS			
OVERALL COMBINED	3.79	0.74	Accept
NSA	3.44	1.12	Accept
APA	3.44	0.62	Accept
OTHER	-	-	-

Model	F Critical Value	Test Statistic	Results
SHIP TYPES - SUBMARINES			
OVERALL COMBINED	3.79	0.79	Accept
NSA	3.44	0.67	Accept
APA	4.28	0.85	Accept
OTHER	-	-	-
SHIP TYPES - AMPHIBIOUS			
OVERALL COMBINED	3.79	0.77	Accept
NSA	3.44	0.91	Accept
APA	3.79	0.67	Accept
OTHER	-	-	-
SHIP TYPES - UNDERWAY REPLENISHMENT			
OVERALL COMBINED	-	-	-
NSA	-	-	-
APA	-	-	-
OTHER	-	-	-

APPENDIX B

AUTOCORRELATION AND TEST RESULTS

The models of this thesis were tested for autocorrelation in the disturbances. The null hypothesis tested was that no autocorrelation existed, and the alternative hypothesis was that the successive disturbances were positively correlated. The starting point was the following identity:

$$E(d_{a+1} - d_a)^2 = E(d^2_{a+1}) + E(d^2_a) - 2E(d_a d_{a+1}),$$

where d_a is the disturbance for month a. When successive disturbances are positively correlated, the left-hand expectation will be smaller than when they are uncorrelated because of the negative sign of $-2E(d_a d_{a+1})$. To the extent that the residuals are satisfactory approximations to the corresponding disturbances, there will be a smaller result for $(d_{a+1} - d_a)^2$. These considerations lead to the Durbin-Watson statistic:

$$d = \frac{\sum_{a=1}^{n-1} (e_{a+1} - e_a)^2}{\sum_{a=1}^{n} e_a^2},$$ where e_a is the residual

for month a. The null hypothesis is rejected in favor of the alternative hypothesis that the disturbances are positively autocorrelated when d takes a sufficiently small value. When the alternative hypothesis states that the disturbances are either positively or negatively autocorrelated, the critical region consists of both small and large values of d.

Durbin and Watson (1950, 1951) formulated bounds (d_L, d_U) for each significance limit. The procedure is then to reject the null hypothesis in favor of the alternative hypothesis if $d < d_L$, to draw no conclusion if d falls in (d_L, d_U) and to declare the null hypothesis as acceptable if $d > d_U$). A more detailed explanation of the test is contained in reference (3).

The upper and lower limits, the test statistic calculated and the results of the test are included below for each model within this thesis:

DURBIN-WATSON TESTS AND RESULTS

Model	Lower Limit	Upper Limit	Test Statistic	Results
NAVY-WIDE MODELS				
OVERALL COMBINED	1.13	1.54	1.83	Accept null hypothesis
NSA	1.13	1.54	2.59	Accept
APA	1.03	1.67	2.03	Accept
OTHER	0.93	1.81	1.82	Accept
PACIFIC OCEAN MODELS				
OVERALL COMBINED	1.13	1.54	1.50	No conclusion
NSA	-	-	-	-
APA	1.13	1.54	1.37	No conclusion
OTHER	1.22	1.42	2.56	Accept
ATLANTIC OCEAN MODELS				
OVERALL COMBINED	-	-	-	-
NSA	1.13	1.54	2.46	Accept
APA	1.03	1.67	2.50	Accept
OTHER	1.22	1.42	1.58	Accept

Model	Lower Limit	Upper Limit	Test Statistic	Results
SHIP TYPES - DESTROYERS				
OVERALL COMBINED	1.22	1.42	1.26	No conclusion
NSA	1.22	1.42	1.82	Accept
APA	1.13	1.54	1.69	Accept
OTHER	1.22	1.42	1.50	Accept
SHIP TYPES - CRUISERS				
OVERALL COMBINED	1.13	1.54	1.80	Accept
NSA	1.22	1.42	2.81	Accept
APA	1.22	1.42	1.26	No conclusion
OTHER	-	-	-	-
SHIP TYPES - SUBMARINES				
OVERALL COMBINED	1.13	1.54	1.73	Accept
NSA	1.22	1.42	2.28	Accept
APA	1.03	1.67	2.36	Accept
OTHER	-	-	-	-
SHIP TYPES - AMPHIBIOUS				
OVERALL COMBINED	1.13	1.54	2.07	Accept
NSA	1.22	1.42	2.10	Accept
APA	1.13	1.54	2.77	Accept
OTHER	-	-	-	-
SHIP TYPES - UNDERWAY REPLENISHMENT				
OVERALL COMBINED	-	-	-	-
NSA	-	-	-	-
APA	-	-	-	-
OTHER	-	-	-	-

APPENDIX C

TESTS FOR NORMALITY OF RESIDUALS

Since most assumptions used in the models of this thesis depend on the normal distribution of the data and residuals, chi-square goodness of fit tests were performed to ensure the normality assumption was acceptable. The results were that the normality assumption was acceptable in the models of this thesis. An example of one of the tests performed on one of the models of the thesis is contained below.

A chi-square goodness of fit test was performed on the residuals of the model for Navy-wide Overall RPC. The procedure used is contained in reference (2).

Interval (in millions)	Theoretical Frequency (F_i)	Observed Frequency (f_i)	$\frac{(f_i - F_i)^2}{F_i}$
less than -50	0.4	0.0	0.40
Between -50 and -40	0.6	0.0	0.60
Between -40 and -30	1.0	3.0	4.00
Between -30 and -20	2.0	0.0	2.00
Between -20 and -10	3.0	5.0	1.33
Between -10 and 0	3.5	4.0	0.07
Between 0 and 10	3.5	2.0	0.64
Between 10 and 20	3.0	2.0	0.33
Between 20 and 30	2.0	2.0	0.00
Between 30 and 40	1.0	2.0	1.00
Between 40 and 50	0.6	1.0	0.27
More than 50	0.4	0.0	0.40
			11.04

5% Critical chi-square value: 16.92

Result: Since 11.04 is less than 16.92, the hypothesis of normality was accepted.

APPENDIX D

The attached list of ships is that actually used in the development of the models. Although data was originally collected for 474 ships, only these 326 satisfied the arbitrary RPC data reporting requirements established for use in this thesis. Any ship not in overhaul with three or more consecutive months of zero RPC data in all three categories (APA, NSA and Other) has been excluded from this listing. This action eliminates two significant classes of ships, Carriers and AFS's, from consideration and reduces the AD's considered to one ship. This data purification action was taken as an attempt to insure that only relatively consistent and presumably accurate reporting units were considered, thus improving confidence in study conclusions.

The three codes are defined and interpreted as follows:

1. RPC - Designates categories of repair part consumption data (APA, NSA, Other) for which the ship has less than three consecutive months of zeros during the 24 month period considered (i.e., "good" report categories).

A = APA only	G = APA, NSA and Other
B = APA and NSA	N = NSA only
C = APA and Other	O = Other only
D = NSA and Other	

2. FC - Fuel consumption data code indicating ships missing fuel consumption data for four or more consecutive months (both FCIN and FCUW missing for each month considered).

1 = Good FC data

0 = Incomplete ("bad") FC data

3. O/H - The overhaul code is used to identify ships that underwent some form of overhaul during the reporting period considered (July 1970 - June 1972).

Y = Ship was in overhaul during the period

N = Ship was not in overhaul during the period

SHIP LISTING

TYPE	HULL #	RPC	FC	O/H	TYPE	HULL #	RPC	FC	O/H
				UNDERWAY REPLENISHMENT					
AE	21	G	1	N	AE	22	N	O	Y
AE	23	G	1	Y	AE	24	G	O	Y
AE	25	B	O	N	AE	26	G	O	N
AE	27	G	1	N	AE	28	G	1	Y
AF	52	G	1	N	AF	56	B	1	N
AF	58	D	1	Y	AF	59	G	O	Y
AO	51	D	O	Y	AO	98	D	1	N
AO	99	G	1	N	AO	106	N	O	N
AO	107	D	O	N	AO	108	G	1	Y
AO	109	G	1	N	AO	143	B	1	Y
AO	144	G	1	Y	AO	145	N	1	Y
AO	146	B	O	N	AO	148	G	1	N
AOE	1	G	O	Y	AOE	2	G	O	Y
AOG	50	N	1	N	AOG	55	N	1	Y
AOG	56	N	1	Y					
				CRUISERS					
CG	10	G	1	N	CG	11	G	O	N
CG	12	G	1	Y	CGN	9	G	1	Y
CLG	4	G	1	Y	CLG	5	G	1	Y
CLG	6	G	1	Y	CLG	7	G	1	N
				DESTROYERS					
DD	714	G	1	Y	DD	715	G	1	Y
DD	717	B	O	Y	DD	718	N	O	Y
DD	719	B	O	Y	DD	743	B	O	Y
DD	782	N	O	N	DD	783	B	O	N
DD	786	B	O	N	DD	817	G	1	Y
DD	818	G	1	Y	DD	824	G	1	Y

TYPE	HULL #	RPC	FC	O/H	TYPE	HULL #	RPC	FC	O/H
				DESTROYERS Cont'd					
DD	826	G	O	N	DD	827	B	1	Y
DD	837	G	1	N	DD	840	G	1	N
DD	845	G	O	N	DD	849	G	1	Y
DD	851	B	O	Y	DD	853	G	1	Y
DD	865	G	1	N	DD	866	G	1	Y
DD	867	G	1	Y	DD	868	G	1	Y
DD	873	G	1	Y	DD	875	B	1	Y
DD	876	B	O	Y	DD	878	G	1	N
DD	881	G	1	Y	DD	886	B	O	Y
DD	890	G	1	Y	DD	931	G	1	Y
DD	933	G	1	Y	DD	938	G	1	Y
DD	941	G	1	Y	DD	942	G	1	N
DD	943	G	1	Y	DD	944	G	1	N
DD	945	G	O	Y	DD	946	B	1	Y
DD	948	B	1	Y	DD	951	B	O	Y
DDG	2	G	1	Y	DDG	3	G	1	Y
DDG	4	G	1	Y	DDG	5	G	1	Y
DDG	6	G	1	N	DDG	7	G	O	Y
DDG	8	G	1	N	DDG	9	G	O	N
DDG	10	G	1	Y	DDG	11	G	1	Y
DDG	12	G	O	N	DDG	13	G	1	Y
DDG	14	G	1	Y	DDG	15	G	O	N
DDG	16	G	O	Y	DDG	17	G	1	Y
DDG	18	G	1	Y	DDG	19	G	1	Y
DDG	20	G	1	N	DDG	21	G	1	Y
DDG	22	G	1	Y	DDG	23	G	1	Y
DDG	24	G	1	Y	DDG	31	G	1	Y
DDG	32	G	1	Y	DDG	33	G	1	Y
DDG	34	G	O	Y	DE	1015	G	1	N
DE	1021	B	1	N	DE	1022	G	1	N
DE	1033	B	1	Y	DE	1035	B	1	Y
DE	1036	B	1	Y	DE	1037	G	1	Y
DE	1038	G	1	Y	DE	1040	G	1	Y

TYPE	HULL #	RPC	FC	O/H	TYPE	HULL #	RPC	FC	O/H
					DESTROYERS Cont'd				
DE	1041	G	1	Y	DE	1043	G	1	N
DE	1044	G	1	Y	DE	1045	G	1	N
DE	1047	G	1	Y	DE	1048	G	1	Y
DE	1049	G	1	Y	DE	1050	B	1	Y
DE	1051	G	1	Y	DE	1052	G	1	Y
DE	1053	G	O	Y	DE	1054	G	O	Y
DE	1055	G	O	N	DE	1056	G	1	Y
DE	1058	G	1	Y	DE	1059	G	1	Y
DE	1060	G	O	Y	DE	1061	G	1	Y
DE	1062	G	1	Y	DE	1068	G	1	Y
DE	1072	G	1	Y	DEG	1	G	1	Y
DEG	2	G	1	Y	DEG	3	G	1	Y
DEG	4	G	1	N	DEG	5	G	1	Y
DEG	6	G	1	Y	DLG	6	G	1	Y
DLG	8	G	1	Y	DLG	10	G	O	N
DLG	11	G	1	Y	DLG	12	C	1	Y
DLG	13	G	1	N	DLG	15	G	1	Y
DLG	16	G	1	N	DLG	17	G	1	N
DLG	21	G	O	Y	DLG	26	G	1	Y
DLG	27	G	1	N	DLG	28	G	1	N
DLG	29	G	1	Y	DLG	30	G	1	Y
DLG	31	G	1	Y	DLG	32	G	1	N
DLG	33	G	O	N	DLG	34	G	1	Y
DLGN	25	G	1	N	DLGN	35	G	1	N
					AMPHIBIOUS				
LPD	1	G	1	N	LPD	2	G	O	N
LPD	3	G	1	Y	LPD	4	G	1	N
LPD	5	G	1	Y	LPD	6	G	O	N
LPD	7	G	O	N	LPD	8	G	O	Y
LPD	9	B	O	N	LPD	10	D	O	N
LPD	11	G	1	Y	LPD	13	G	1	Y
LPH	3	G	1	N	LPH	7	G	1	Y
LPH	9	G	1	N	LSD	28	N	O	Y

TYPE	HULL #	RPC	FC	O/H	TYPE	HULL #	RPC	FC	O/H
				AMPHIBIOUS Cont'd					
LSD	29	B	O	Y	LSD	30	G	1	Y
LSD	31	G	O	Y	LSD	32	G	1	N
LSD	33	B	O	Y	LSD	34	N	1	N
LSD	35	G	O	Y	LSD	36	G	O	N
LST	1179	G	1	Y	LST	1180	N	1	Y
LST	1181	B	1	Y	LST	1182	G	1	Y
LST	1183	G	1	Y	LST	1184	B	1	Y
				SUBMARINES					
SS	344	N	1	Y	SS	346	B	1	Y
SS	351	N	1	Y	SS	416	B	1	Y
SS	425	N	1	Y	SS	490	N	1	Y
SS	563	B	1	Y	SS	564	N	1	Y
SS	565	B	1	Y	SS	566	N	1	N
SS	567	N	1	Y	SS	572	B	1	Y
SS	576	N	1	Y	SS	580	B	1	Y
SS	581	B	1	Y	SS	582	B	1	Y
SSBN	598	B	1	Y	SSBN	599	B	1	Y
SSBN	600	B	1	Y	SSBN	601	B	1	Y
SSBN	602	B	1	N	SSBN	608	B	1	N
SSBN	609	G	1	N	SSBN	610	B	1	N
SSBN	611	G	1	N	SSBN	616	G	1	N
SSBN	617	G	1	N	SSBN	618	B	1	N
SSBN	619	B	1	N	SSBN	627	B	1	Y
SSBN	628	B	1	Y	SSBN	629	B	1	Y
SSBN	630	B	1	Y	SSBN	631	B	1	Y
SSBN	632	B	1	Y	SSBN	633	B	1	Y
SSBN	634	B	1	Y	SSBN	635	B	1	Y
SSBN	636	B	1	Y	SSBN	640	N	1	Y
SSBN	641	B	1	Y	SSBN	642	B	1	Y
SSBN	643	B	1	Y	SSBN	644	B	1	Y
SSBN	645	N	1	Y	SSBN	654	B	1	Y
SSBN	658	B	O	N	SSBN	659	B	1	N
SSN	571	B	O	N	SSN	579	B	1	Y
SSN	585	B	1	Y	SSN	587	B	1	Y

TYPE	HULL #	RPC	FC	O/H	TYPE	HULL #	RPC	FC	O/H
SSN	590	B	1	N	SSN	592	B	O	N
SSN	596	G	O	Y	SSN	597	B	1	N
SSN	607	B	1	N	SSN	638	B	O	N
SSN	639	G	O	Y	SSN	646	G	1	Y
SSN	648	B	1	Y	SSN	649	G	O	N
SSN	650	G	O	Y	SSN	651	G	O	Y
SSN	652	G	O	Y	SSN	653	G	O	Y
SSN	661	G	O	Y	SSN	662	B	O	N
SSN	663	B	O	Y	SSN	664	G	O	N
SSN	667	B	O	Y	SSN	668	G	O	N
SSN	669	G	O	Y	SSN	670	B	O	Y
SSN	673	G	O	Y	SSN	674	G	O	Y
				MISCELLANEOUS					
AD	26	N	1	Y	AG	153	N	1	Y
AR	6	G	O	Y	AR	7	N	O	N
ARC	2	D	1	N	ARC	3	G	1	Y
ARC	4	N	1	Y	ARS	8	D	1	N
ARS	23	D	1	N	ARS	24	D	1	N
ARS	25	N	1	N	ARS	38	D	1	Y
ARS	39	N	1	N	ARS	40	N	1	Y
ARS	42	N	1	Y	ARS	43	D	1	N
AS	18	D	1	N	AS	32	B	1	N
AS	34	N	1	N	ASR	8	N	1	N
ASR	9	N	1	N	ASR	13	N	1	Y
ASR	14	N	1	N	ASR	15	N	1	Y
ASR	16	N	1	N	ATF	76	N	1	N
ATF	84	N	1	N	ATF	86	N	1	N
ATF	92	N	1	Y	ATF	100	N	1	Y
ATF	101	N	1	Y	ATF	103	N	1	Y
ATF	105	N	1	Y	ATF	106	N	1	Y
ATF	110	N	1	N	ATF	113	N	1	N
ATF	149	N	1	Y	ATF	156	N	1	Y
ATF	157	N	1	Y	ATF	158	N	1	Y
ATF	159	N	1	Y	ATF	160	G	1	Y

TYPE	HULL #	RPC	FC	O/H	TYPE	HULL #	RPC	FC	O/H
				MISCELLANEOUS Cont'd					
ATF	161	D	1	Y	ATF	162	N	1	Y
MSO	433	B	1	Y	MSO	446	N	1	Y
MSO	449	N	1	Y	PG	85	N	1	Y
PG	86	N	1	Y	PG	88	N	1	Y
PG	89	N	1	Y	PG	92	N	1	Y
PG	93	N	1	Y	PG	94	N	1	Y
PG	95	N	1	Y	PG	97	N	1	Y
PG	101	N	1	Y					

APPENDIX E

The following tables list information extracted from the master tape by using the data compilation program with the exception of the five categories of overhaul mandays (RMDY, SMDY, TMDY, UNDY and VMDY). It should be noted that although twenty-four months of data are available, models were constructed on the basis of the first twenty-one months of information, allowing use of months 22, 23, and 24 for testing the predictive powers of the models. The following explanation of headings and the methods of calculating the respective entries is described below:

Month: Month 1-24 are the respective months over which the data pertained beginning with July 1970 (Month 1) and ending with June 1972 data (Month 24). This period was selected as the most current for which 3M data on repair part consumption could be extracted. A new generation of 3M data collection was initiated in January 1970. Prior RPC information was difficult if not impossible to extract and if extracted would have been incompatible with the new generation data. The Maintenance Support Office advised extracting data after approximately July 1970 to insure complete implementation of the most recent 3M data collection process. It should be observed that data concerning overhaul information, steaming hours, and fuel consumption was available as far back as 1965.

RPC-APA (NSA, OTHER): This figure represents, in dollars, the total of all repair part consumption data reported for the ships in the model and the particular month indicated. APA, NSA and Other designate the type of repair part consumption summed as reported by the Maintenance Support Office. In providing the repair part consumption data, the Maintenance Support Office developed programs to extract the extended dollar value of material the subject ships reported consumed in the respective months. This was done by categories, summing all even cog (APA), odd cog (NSA), and part numbered items (Other) separately for each ship by month.

RPC-total: This is the sum of RPC-APA, NSA and Other for the report month.

AGE: This data element is obtained by adding the ages (in months from commissioning date) of all ships in the particular model for the report month.

TSLOH: The sum of time (in months) since the completion of the last overhaul for all ships in the model.

SHIN/SHUW: The sum for the report month of the modeled ships steaming hours in port/steaming hours underway, in hours.

FCIN/FCUW: The sum for the report month of the modeled ships fuel consumption in port/fuel consumption underway, in gallons.

TOTMDY: The total mandays expended during the last overhaul, summed for all ships modeled by report month.

SHIPS: The number of different ships used in the particular model. Note that this figure remains constant from month to month for each model.

Data Sources: The Repair Part Consumption data was obtained from the Maintenance Support Office as previously described. This data is initially obtained from source documents originated monthly by each ship, key punched and finally converted to tape storage in MSO.

The data elements of AGE, TSLOH and TOTMDY were obtained from CNA. This information is collected by the Naval Ships Systems Command (NAVSHIPS) from overhaul departure reports and general historical files including information such as home ports, type command, types of overhaul, etc. CNA had previously obtained this data from NAVSHIPS.

The remaining data of SHIN, SHUW, FCIN and FCUW was also obtained from CNA. This information is reported monthly by ships, based on ships logs, to the Maintenance Support Office. CNA had previously obtained this information on tape from MSO.

It should be noted that nearly all of the information used in this study originates with ship reports. It is often handwritten and requires key punching and other processing before final conversion to magnetic tape records. This entire process is hardly infallible and it is likely to create some differences between the actual factors and the data incorporated herein. This, however, represents the best available information and this data was purified to the maximum extent feasible to insure the most reliable information available was used in this study.

NAVY-WIDE APA MODEL

MONTH	RPC-APA	AGE	TSLOH	SHIN	SHUW	FOIN	FOUW	TOTMDY	#SHIPS
1	246738588	21076	4172	30743	38469	6031557	20992612	10796108	182
2	231937387	21256	4104	33057	44571	6708200	20853278	11611777	182
3	244025297	21438	4103	28397	44996	4896168	23654798	10967357	182
4	262380402	21620	4147	27729	45747	5552136	21867024	11106274	182
5	215736770	21802	4250	23281	37046	4723193	17038358	11365333	182
6	211245931	21984	4179	18705	27867	3619673	9143728	11432202	182
7	232906773	22166	4268	21776	34006	4942481	13890623	10908699	182
8	234659585	22348	4116	20120	40254	4036211	19319634	10906607	182
9	262771281	22530	4098	25369	38342	5957835	16825434	10438013	182
10	262313085	22712	3969	25141	40406	5513890	19958654	10272822	182
11	232116126	22894	3949	22405	40353	5286513	18600587	10279893	182
12	239091481	23076	3781	25051	38066	6628238	21731274	10151812	182
13	280764932	23258	3873	27376	44737	6604109	26212834	10178332	182
14	287454326	23440	3992	25560	41985	6420691	23896514	9839171	182
15	280616273	23622	3822	26552	42642	6757162	23079648	10327194	182
16	247327248	23804	3773	23930	44711	6001297	28417745	10129677	182
17	287574376	23986	3799	21199	45180	4963558	25374976	9885370	182
18	268213398	24168	3822	18182	32899	4095384	17846830	9939699	182
19	314073537	24350	3849	20531	39533	4757072	20855286	9783810	182
20	317998547	24532	3967	24718	43763	5992064	27434333	95C7063	182
21	339659932	24714	4049	21269	44684	5852916	27675689	9504494	182
22	320902845	24896	4116	17398	46390	4705688	26880827	9540702	182
23	340016840	25078	4058	17583	50282	4307529	29567068	9810323	182
24	276912406	25260	4090	22574	50941	5987431	30699004	9817830	182

NAVY-WIDE NSA MODEL

MONTH	RPC-NSA	AGE	TSLOH	SHIN	SHUW	FCIN	FCUW	TOTMDY	#SHIPS
24	276912406	25260	4090	22574	50941	5987431	3C699004	9817830	182
24	276912406	25260	4090	22574	50941	5987431	3C699004	9817830	182
24	276912406	25260	4090	22574	50941	5987431	3C699004	9817830	182
24	276912406	25260	4090	22574	50941	5987431	3C699004	9817830	182
24	276912406	25260	4090	22574	50941	5987431	3C699004	9817830	182
24	276912406	25260	4090	22574	50941	5987431	3C699004	9817830	182
24	276912406	25260	4090	22574	50941	5987431	3C699004	9817830	182
24	276912406	25260	4090	22574	50941	5987431	3C699004	9817830	182
24	276912406	25260	4090	22574	50941	5987431	3C699004	9817830	182
24	276912406	25260	4090	22574	50941	5987431	3C699004	9817830	182
24	276912406	25260	4090	22574	50941	5987431	3C699004	9817830	182
24	276912406	25260	4090	22574	50941	5987431	3C699004	9817830	182
24	276912406	25260	4090	22574	50941	5987431	3C699004	9817830	182
24	276912406	25260	4090	22574	50941	5987431	3C699004	9817830	182
24	276912406	25260	4090	22574	50941	5987431	3C699004	9817830	182
24	276912406	25260	4090	22574	50941	5987431	3C699004	9817830	182
24	276912406	25260	4090	22574	50941	5987431	3C699004	9817830	182
24	276912406	25260	4090	22574	50941	5987431	3C699004	9817830	182
24	276912406	25260	4090	22574	50941	5987431	3C699004	9817830	182
24	276912406	25260	4090	22574	50941	5987431	3C699004	9817830	182
24	276912406	25260	4090	22574	50941	5987431	3C699004	9817830	182
24	276912406	25260	4090	22574	50941	5987431	3C699004	9817830	182
24	276912406	25260	4090	22574	50941	5987431	3C699004	9817830	182
24	276912406	25260	4090	22574	50941	5987431	3C699004	9817830	182
24	276912406	25260	4090	22574	50941	5987431	3C699004	9817830	182

NAVY-WIDE OTHER MODEL

MONTH	RPC-OTHER	AGE	TSLOH	SHIN	SHLW	FCIN	FCLW	TOTMDY	#SHIPS
1	14396251	36295	5319	42939	50858	7067794	22982561	11698247	251
2	18285550	36544	5312	44949	55038	7770116	22530421	12497960	251
3	15460578	36795	5280	39634	56375	5703C5C	25822928	11861749	251
4	18658506	37046	5393	39392	56876	6566294	23668671	12000666	251
5	19197279	37297	5524	34537	49870	5652315	19115198	12246288	251
6	18778663	37548	5257	29706	37497	4397522	10548982	12328620	251
7	25539943	37799	5382	33197	46033	5792554	15637614	11801821	251
8	22308864	38050	5213	33143	51578	4937355	21481119	11837231	251
9	28231122	38301	5196	39816	49139	68084C4	19370152	11368351	251
10	28500373	38552	5127	35995	52619	6317146	22913414	11204873	251
11	28256115	38803	5109	34072	53265	6058741	21127430	11216348	251
12	29641154	39054	4960	38410	50993	7385766	24655169	11095373	251
13	27705197	39305	5072	38617	56204	7412070	28988179	11135525	251
14	29851104	39556	5221	38551	55615	7258395	26383970	10793049	251
15	30776291	39807	5048	40117	54932	7434167	24945566	11283354	251
16	2545167C	40058	5058	36165	56863	6908598	30443115	11086827	251
17	29805374	40309	5072	32280	59584	5726021	27671806	10858692	251
18	24512818	40560	5060	29869	39620	4880599	18716491	10916969	251
19	21847665	40811	5127	32270	47987	5674282	22235209	10763500	251
20	22568823	41062	5314	35732	55911	6967948	29833205	10486753	251
21	21417882	41313	5465	31324	57587	6666856	29894370	10484184	251
22	22448002	41564	5546	28125	60032	5392307	29522099	10498174	251
23	24355274	41815	5402	29460	65720	5210620	32499083	11032383	251
24	25134482	42066	5480	34832	65349	6966202	33718832	11042566	251

NAVY-WIDE OVERALL COMBINED

MONTH	RPC-TOTAL	AGE	TSLOH	SHIN	SHUW	FCIN	FCUW	TOTMDY	#SHIPS
1	371944868	16887	2515	27635	27047	5521933	19808468	5041611	134
2	32872C153	17019	2555	28946	32208	6168161	20294189	5166217	134
3	341631706	17153	2544	25051	32156	4523772	22813930	4742289	134
4	365884584	17287	2600	25712	32047	5297382	20143238	4755359	134
5	320417241	17421	2723	21121	2638C	4541644	16279166	4759418	134
6	3C795C679	17555	2691	18096	17513	3313886	9002291	4755312	134
7	352285463	17689	2788	19886	23816	4559416	13279904	48C1031	134
8	342526C81	17823	2742	19446	28863	3662CC9	18584693	4866573	134
9	385361954	17957	2638	24474	25061	5518229	15640401	4730648	134
10	392791564	18091	2574	23770	28905	521C5C2	19325803	4569301	134
11	337898779	18225	2549	21834	26419	4965243	17091690	4621590	134
12	353764328	18359	2411	24112	26942	6149393	19967168	4628073	134
13	426485826	18493	2497	25845	30838	6121279	24416720	465489C	134
14	423018399	18627	2584	23337	29938	5777938	22193875	4667727	134
15	417557C84	18761	2526	25171	28438	6263775	21209736	49CC025	134
16	371286767	18895	2514	22591	32128	5594647	26838969	4984910	134
17	359836717	19029	2606	20503	3194C	4543449	23985762	4994899	134
18	36928268C	19163	2624	16208	19455	371C542	16552583	5C42983	134
19	437952110	19297	2669	19382	24941	4533154	1938C624	5061449	134
20	423994C69	19431	2766	21717	31492	5693166	257C9C34	5C75217	134
21	4421C7115	19565	2844	18607	32087	5415758	26363341	5C64148	134
22	448989487	19699	2869	16472	31448	42567C3	25210362	5C92356	134
23	501181881	19833	2836	16583	34607	3909469	27783557	5C96977	134
24	358473622	19967	2865	21778	34428	5621814	29276146	5154469	134

ATLANTIC APA MODEL

MONTH	RPC-APA	AGE	TSLOH	SHIN	SHUW	FOIN	FOUW	TOTMDY	#SHIPS
1	219686350	17711	3484	26478	37176	5259182	17745953	10551516	162
2	209429753	17871	3509	29444	39907	5850671	17756514	11303711	162
3	213256254	18033	3537	26576	40653	4385842	19517069	10984212	162
4	228170997	18195	3618	24208	41596	4884910	17508095	11008943	162
5	189422377	18357	3694	20907	38548	4145483	14816099	10883002	162
6	179120935	18519	3613	16780	27430	3119226	7857820	10949540	162
7	208771162	18681	3710	20140	33547	4423266	12032647	10035318	162
8	210576592	18843	3598	16540	39564	3414368	16478372	10278791	162
9	246711028	19005	3630	22495	38278	5194184	13553304	9781455	162
10	238263877	19167	3484	23052	39021	4673485	15697469	9601898	162
11	218273666	19329	3563	19842	38465	4474909	14772365	9642173	162
12	241039392	19491	3428	21408	33505	4714737	15681167	9267215	162
13	253397870	19653	3542	23053	40351	5268062	19024859	9294032	162
14	261514397	19815	3644	21385	37715	5064389	16974414	9065434	162
15	260343650	19977	3579	22570	38669	5475241	16567688	9559419	162
16	219466183	20139	3582	19571	40719	4883928	21280141	9337067	162
17	253795653	20301	3593	17875	39500	4302018	18314436	9094326	162
18	250685219	20463	3689	14762	26067	3454833	10929680	9109149	162
19	287504903	20625	3696	16754	33324	4073888	13580071	8953260	162
20	307407727	20787	3728	20239	39146	4632715	20729242	8681904	162
21	329822508	20949	3822	18987	39468	4731365	20583049	8685270	162
22	304015177	21111	3875	15066	41698	3896619	19016605	8713478	162
23	316793977	21273	3797	15599	46454	3649176	22984951	8983099	162
24	257510754	21435	3847	20684	46124	5284220	21637037	9001585	162

ATLANTIC NSA MODEL

MONTH	RPC-NSA	AGE	TSLOH	SHIN	SHUW	FCIN	FCLW	TOTMDY	#SHIPS
1	168624110	24352	3906	32105	34190	6025383	17514433	9664176	170
2	169649253	24522	3938	34209	35350	6768741	18070017	10015415	170
3	159348681	24692	3974	29268	39376	5064849	21042366	9695916	170
4	167579814	24862	4081	27587	38967	5763000	18768477	9710881	170
5	148566773	25032	4135	24702	35212	4930640	16316476	9575292	170
6	147451149	25202	3907	23034	24417	3808267	8518007	10053217	170
7	181791524	25372	3988	26277	32740	5179182	13095396	9520699	170
8	160467148	25542	3798	23289	36578	4119070	17926332	9801674	170
9	183758086	25712	3838	28043	34354	5929041	14608755	9304338	170
10	187692947	25882	3738	26753	37542	5359314	17285847	9137159	170
11	161337138	26052	3776	24154	36734	5022564	16218438	9179796	170
12	177574375	26222	3624	27216	32207	5294433	17403570	9195042	170
13	190326783	26392	3697	27154	38148	5938995	20679810	9235491	170
14	182638193	26562	3825	26478	38738	5703809	18600353	9014403	170
15	167146301	26732	3731	28624	36474	5849786	17918068	9511477	170
16	170077238	26902	3785	24604	39730	5365358	22493957	9269237	170
17	180305931	27072	3723	22178	40761	4759633	19338897	9042668	170
18	171949363	27242	3748	19734	23607	3852571	11277084	9058325	170
19	195220042	27412	3763	21776	32087	4599792	14432959	8902436	170
20	173393433	27582	3869	24928	39020	5261686	21280122	8625689	170
21	193009506	27752	3995	22838	39737	5307486	21354752	8634189	170
22	191876467	27922	4022	19908	39618	4197743	19639788	8639534	170
23	222393502	28092	3878	21548	45030	4269341	23523334	9174155	170
24	150133997	28262	3947	26371	43916	5837130	21877690	9206072	170

ATLANTIC OTHER MODEL

MONTH	RPC-OTHER	AGE	TSLOH	SHIN	SHUW	FCIN	FCLW	TOTMDY	#SHIPS
1	11265865	15115	2221	23408	28029	4805443	17011523	5321670	125
2	13117259	15238	2256	25298	29905	5359018	17780222	5737596	125
3	12463078	15363	2247	22735	29847	4095630	19109027	5418097	125
4	14010006	15488	2291	22108	29384	4714780	16303867	5442828	125
5	12170684	15613	2407	18821	28692	4017953	14238382	5446887	125
6	10804151	15738	2368	16405	18385	2860255	7987300	5482781	125
7	18446745	15863	2484	18646	24861	4087930	11734538	5097781	125
8	15922220	15988	2483	16178	29871	3093286	16233936	5141888	125
9	21137814	16113	2485	21348	27340	4808065	12856881	4977436	125
10	20964251	16238	2415	21833	29956	4452338	15791084	4801723	125
11	24158518	16363	2457	19285	26421	4237303	13974427	4841998	125
12	25582033	16488	2329	20383	26014	4301295	15145181	4458317	125
13	22910003	16613	2406	22159	28693	4826550	18353933	4485134	125
14	23553015	16738	2477	19555	28105	4663714	16426668	4481756	125
15	23382724	16863	2535	21458	27749	5115963	15990201	4720016	125
16	18217904	16988	2507	18976	30431	4643667	20969310	4764664	125
17	22858395	17113	2590	17345	29988	3941023	18232445	4774653	125
18	20751074	17238	2649	13536	17661	3051706	10488912	4789476	125
19	14460158	17363	2685	16497	23113	3835378	12950080	4807942	125
20	17076889	17488	2707	18192	29159	4360727	20029888	4827101	125
21	14709183	17613	2808	16708	29655	4363004	20432056	4821967	125
22	15594218	17738	2824	14348	28712	3510572	18502853	4850175	125
23	17275645	17863	2782	14771	32921	3334791	22120105	4854796	125
24	18808840	17988	2795	19587	32551	4938151	21136138	4873282	125

ATLANTIC OVERALL COMBINED

MONTH	RPC-TOTAL	AGE	TSLOH	SHIN	SHUW	FCIN	FCUW	TOTMDY	#SHIPS
1	288094757	12307	1856	18720	18454	4538C3C	14880830	4359996	95
2	261374597	12402	1868	19612	22001	5159913	16612149	4390922	95
3	266659857	12497	1829	17941	22328	3978405	18521539	4071423	95
4	273703776	12592	1861	17733	21053	4434197	15953449	4086388	95
5	237800801	12687	1947	15118	19320	3722777	13906020	4090447	95
6	235536570	12782	1921	12251	12222	2716411	7601811	4119888	95
7	279686226	12877	2016	14949	18132	3921485	11218889	4119888	95
8	279598463	12972	2023	12618	21332	2965567	15604603	4162100	95
9	311229020	13067	1995	17660	18336	4750731	12369364	3997648	95
10	315644870	13162	1933	16725	21495	4295551	14836497	3834313	95
11	278589525	13257	1945	15093	20337	4086034	13643490	3874588	95
12	314645425	13352	1797	16108	18639	4168559	14825023	3875907	95
13	336472952	13447	1844	17399	22420	4739900	18068734	3902724	95
14	334061755	13542	1903	16069	21911	4538357	15802270	3906856	95
15	319734320	13637	1931	18041	20632	4931238	15706476	4145116	95
16	289183288	13732	1916	14867	23763	4321009	20358909	4169876	95
17	313467329	13827	1969	13840	22852	3657302	16861609	4179865	95
18	297447361	13922	1998	10760	12596	2833908	10108474	4194688	95
19	339615983	14017	2004	13274	17391	3583274	12451979	4213154	95
20	334797539	14112	2062	15324	22582	4144714	18514074	4226922	95
21	345576467	14207	2157	13426	22950	4198598	19148550	4226922	95
22	347941024	14302	2143	11254	20363	3144261	16997960	4255130	95
23	395190980	14397	2071	11521	24692	3041465	20654716	4259751	95
24	272318819	14492	2088	16074	23087	4484460	19146119	4288992	95

PACIFIC APA MODEL

MONTH	RPC-APA	AGE	TSLOH	SHIN	SHUW	FCIN	FCLW	TOTMDY	#SHIPS
1	55696718	4618	972	7518	10783	939246	4897866	1645870	49
2	51619184	4665	901	7594	13510	929062	3773666	2094344	49
3	60988662	4714	901	5416	11411	511121	4140904	1769423	49
4	67003778	4763	875	6669	13040	692567	4362422	1893375	49
5	54548137	4812	922	4972	8238	588097	2222959	1893375	49
6	56718837	4861	961	3675	7088	504450	1367877	1893706	49
7	50079636	4910	973	3693	7470	526208	1940708	1899425	49
8	46674392	4959	962	5040	9417	626693	2849272	1653860	49
9	51798229	5008	941	4764	9884	764965	3501300	1682602	49
10	55666677	5057	949	5145	9726	845465	4489430	1684590	49
11	47171305	5106	879	4610	9699	819082	3829043	1651386	49
12	28103883	5155	865	5541	11963	1918655	6074611	1513263	49
13	59222858	5204	872	6986	12096	1338840	7189658	1512966	49
14	62588829	5253	900	6012	10560	1361125	6925743	1394893	49
15	57628724	5302	824	5944	11952	1403996	6571986	1388931	49
16	58629993	5351	758	6227	10926	1314843	7314077	1433654	49
17	63237456	5400	802	4849	11729	808320	7631536	1432088	49
18	47933444	5449	758	4935	11821	794348	7098248	1471594	49
19	64820266	5498	807	5348	12067	839370	7456024	1471594	49
20	64985557	5547	856	6183	11393	1490043	7768514	1471594	49
21	65908406	5596	849	4344	11645	1195285	7790033	1460525	49
22	71129815	5645	892	3376	13923	1067319	8838746	1468525	49
23	73227598	5694	941	2938	12570	779734	7521099	1468525	49
24	65016696	5743	918	3213	14252	967847	10530682	1446791	49

PACIFIC NSA MODEL

MONTH	RPC-NSA	AGE	TSLOH	SHIN	SHOW	FOIN	FOLW	TOTMDY	#SHIPS
1	41192549	11943	1413	10834	16668	1042411	5468128	2034071	81
2	39450906	12022	1374	10740	19688	1001375	4460404	2482545	81
3	41511476	12103	1306	10366	16999	638201	4780562	2165833	81
4	43812904	12184	1312	11805	17909	803294	4900194	2289785	81
5	47507555	12265	1389	9835	14658	721675	2798722	2270996	81
6	40896162	12346	1350	6672	13080	589255	2030975	2275403	81
7	40441821	12427	1394	6920	13293	613372	2542218	2281122	81
8	30668844	12508	1415	9854	15000	818285	3554787	2035557	81
9	37011975	12589	1358	11773	14785	879363	4761397	2064013	81
10	38422776	12670	1389	9242	15077	957832	5627567	2067714	81
11	35298271	12751	1333	9918	16531	1036177	4908992	2036552	81
12	23623528	12832	1336	11194	18786	2091333	7251599	1900331	81
13	49994786	12913	1375	11463	18056	1473075	8308369	1900034	81
14	48318344	12994	1396	12073	16877	1554586	7783617	1778646	81
15	55297138	13075	1317	11493	18458	1584381	7027498	1771877	81
16	42594793	13156	1273	11561	17133	1543240	7949158	1817590	81
17	46313037	13237	1349	10102	18823	966388	8332909	1816024	81
18	35914976	13318	1312	10135	16013	1028028	7439407	1858644	81
19	47092633	13399	1364	10494	15900	1074490	7802250	1861064	81
20	51261324	13480	1445	10804	16891	1706262	8553083	1861064	81
21	47034380	13561	1470	8486	17850	1359370	8539618	1849995	81
22	57050102	13642	1524	8217	20414	1194564	9882311	1858640	81
23	55097397	13723	1524	7912	20690	941279	8975749	1858228	81
24	49052917	13804	1533	8461	21433	1129072	11841142	1836494	81

PACIFIC OTHER MODEL

MONTH	RPC-OTHER	AGE	TSLOH	SHIN	SHLW	FOIN	FOLW	TOTMOY	#SHIPS
1	2668640	2674	522	7133	6943	883242	4448123	597154	32
2	2396157	2704	543	6607	9027	880476	3190869	690834	32
3	2993157	2736	564	4890	7958	42885C	3708078	586405	32
4	2194826	2768	581	6150	9184	605103	384259C	584510	32
5	2864125	28C0	611	4574	5587	532548	2041317	584510	32
6	3272902	2832	641	3389	4623	456677	1096917	584510	32
7	2485373	2864	636	3054	4521	478134	1628078	590229	32
8	2978405	2896	614	4640	6232	570993	2358557	611664	32
9	3736859	2928	531	4754	6120	710986	3011762	640191	32
10	2044639	2960	522	4673	6144	762054	3762774	642179	32
11	3104816	2992	478	4308	5441	731691	3117777	654193	32
12	3784828	3024	481	5572	7209	185216C	4846491	659357	32
13	3497278	3056	513	6068	7502	1296421	6063946	659357	32
14	3731304	3088	534	5308	6385	1118573	5770144	668062	32
15	4105394	3120	441	5329	6837	1269122	5279374	662100	32
16	3239794	3152	437	5460	7198	1147748	6045554	722225	32
17	4956667	3184	469	4611	7052	746803	6323992	722225	32
18	4167541	3216	451	4024	6101	807470	6244635	755486	32
19	4508461	3248	483	4309	6620	853715	6611093	755486	32
20	4340446	3280	515	4978	7851	1463133	6742338	755486	32
21	3864422	3312	491	3700	7808	1130398	6628562	744417	32
22	4849059	3344	523	3044	9790	1002277	7681812	744417	32
23	4277893	3376	555	2741	8318	695997	6602310	744417	32
24	3115872	3408	560	3488	9795	948250	9608659	772668	32

PACIFIC OVERALL COMBINED

MONTH	RPC-TOTAL	AGE	TSLOH	SHIN	SHLW	FOIN	FOLW	TOTMCY	#SHIPS
1	78652195	2372	485	6665	6751	869516	4407147	586354	31
2	62977075	2401	505	6428	8679	875590	3126222	680034	31
3	71596883	2432	525	4568	7560	419900	3632515	575605	31
4	87304781	2463	541	5803	8945	577365	3799313	573710	31
5	78420724	2494	570	4574	5587	532948	2041317	573710	31
6	69854469	2525	599	3389	4623	456677	1096517	573710	31
7	68183127	2556	593	3054	4521	478134	1628078	579429	31
8	59179445	2587	570	4395	6223	562461	2357003	600864	31
9	69736814	2618	531	4292	6009	706775	2994075	629606	31
10	71231342	2649	521	4487	6034	755472	3749322	631594	31
11	55746397	2680	476	4028	5381	727177	3108076	643608	31
12	35150841	2711	478	4970	7091	1845137	4833610	648772	31
13	84398097	2742	509	5512	7434	1290201	6055865	648772	31
14	82999258	2773	529	4944	6383	1112541	5769800	657477	31
15	92113115	2804	435	4965	6835	1263090	5279030	651515	31
16	74614910	2835	430	5146	6906	1143666	6045554	711640	31
17	80901233	2866	461	3985	6958	743088	6323992	711640	31
18	64840939	2897	442	3659	5942	770048	6244629	744901	31
19	90149338	2928	473	3984	6461	816293	6611087	744901	31
20	81713719	2959	504	4948	7613	1459793	6704767	744901	31
21	89595708	2990	479	3668	7463	1129466	6578768	733832	31
22	94258152	3021	510	2963	9592	1001224	7662591	733832	31
23	100771308	3052	541	2186	8129	688782	6591217	733832	31
24	81738500	3083	545	2848	9715	938970	9598040	762083	31

SHIP-TYPE AMPHIBICUS APA

MONTH	RPC-APA	AGE	TSLOH	SHIN	SHUW	FCIN	FCUW	TCINCY	#SHIPS
1	13309399	1019	212	3168	3772	839372	3188005	323328	16
2	5453100	1035	222	3789	3448	1028559	2496520	653817	16
3	8765814	1051	238	3652	2731	778212	1695309	653817	16
4	9685558	1067	241	3145	3695	623777	2492255	651922	16
5	8245540	1083	257	3621	2549	64174C	222C989	651922	16
6	48C6CCC	1099	230	1747	854	188344	592C49	660628	16
7	8944C1C	1115	246	2118	2237	394C14	1737930	66C628	16
8	8269213	1131	216	2620	3208	677127	1936414	696489	16
9	5958800	1147	217	3150	2778	828C56	1791765	364173	16
10	12510520	1163	233	3211	4171	750C6C	2842347	364173	16
11	818C749	1179	249	2845	441C	964154	2579C06	364173	16
12	13835778	1195	265	2899	2778	9566CC	2241760	364173	16
13	1193445C	1211	281	3367	2669	896194	1839863	364173	16
14	151C897C	1227	297	3367	3517	862813	2325687	364173	16
15	12114947	1243	313	4288	2769	914396	2263194	364173	16
16	12238569	1259	290	2928	3349	666862	28C6120	399380	16
17	11172999	1275	266	2320	3125	621629	2616820	4C7937	16
18	9015899	1291	282	2296	833	60176C	581685	4C7937	16
19	9951871	1307	298	2512	2665	6C4862	2164642	4C7937	16
20	162967CC	1323	314	3256	2755	685498	2417612	4C7937	16
21	1258516C	1339	33C	3270	3641	709671	28C5878	4C7937	16
22	93C9C0C	1355	346	2749	3245	723133	2415082	4C7937	16
23	1213C863	1371	362	2897	3316	67C443	2279574	4C7937	16
24	11311C99	1387	378	3497	2705	924852	2392481	4C7937	16

SHIP-TYPE AMPHIBICUS NSA

MONTH	RPC-NSA	AGE	TSLCH	SHIN	SHUK	FCIN	FCLW	TOTMDY	#SHIPS
1	10253335	1188	227	4219	4185	970557	3434316	362385	18
2	13100937	1206	239	4256	3609	1147114	2651036	692874	18
3	8629427	1224	257	3658	3115	847737	2110110	692874	18
4	12367506	1242	262	3586	4195	663729	2903428	690979	18
5	7820178	1260	280	3762	2880	668705	2460242	690979	18
6	5682805	1278	247	2267	1118	316135	768797	704216	18
7	6788486	1296	265	2649	2490	519327	1918644	704216	18
8	9938232	1314	237	3222	3449	801688	2089204	740077	18
9	6022453	1332	240	3936	3480	955781	2261293	407761	18
10	16395760	1350	258	3725	4689	834861	3267847	407761	18
11	12171699	1368	276	2851	4568	982732	2800918	407761	18
12	7895453	1386	294	2924	3306	962920	2635721	407761	18
13	13586076	1404	312	3714	3425	1023274	2414532	407761	18
14	14643151	1422	330	3540	3784	902335	2515298	407761	18
15	12643293	1440	348	4973	3024	1005854	2611282	407761	18
16	10843509	1458	327	3200	3887	758118	3170413	442968	18
17	13069801	1476	305	2348	3330	643725	2751745	451525	18
18	9951236	1494	323	2315	993	612526	651980	451525	18
19	8368576	1512	341	2533	2825	615682	2234937	451525	18
20	12347751	1530	359	3496	3098	766931	2640668	451525	18
21	11104318	1548	377	3515	3805	781974	2961436	451525	18
22	10188555	1566	395	3036	4027	786000	2921771	451525	18
23	14442990	1584	413	3175	4242	726810	2668525	451525	18
24	12506704	1602	431	3911	3557	1074494	2843411	451525	18

SHIP-TYPE AMPHIBICUS OTHER

MONTH	RPC-OTHER	AGE	TSLOH	SHIN	SHUh	FCIN	FCLW	TOTMDY	#SHIPS
1	564415	827	180	2600	3199	765517	2817271	269413	13
2	775900	840	193	3341	3094	782326	2452755	269413	13
3	543071	853	206	2852	2198	606521	1475370	269413	13
4	975652	866	206	2740	2545	540641	1743049	267518	13
5	1433583	879	219	2848	1995	517770	1992857	267518	13
6	762357	892	197	1379	817	172415	576634	275893	13
7	933082	905	210	1552	1852	315989	1507182	275893	13
8	1505135	918	177	2496	2872	547664	1754563	311754	13
9	1083587	931	182	2935	2432	773130	1598227	312322	13
10	1135179	944	195	2558	3800	683303	2638018	312322	13
11	752523	957	208	2599	3563	925180	2067821	312322	13
12	1429341	970	221	2664	1815	802104	1592903	312322	13
13	857185	983	234	3198	2148	890414	1589895	312322	13
14	1347112	996	247	2842	2923	831703	1979934	312322	13
15	1178364	1009	260	3791	2329	887368	1998778	312322	13
16	529062	1022	234	2262	2778	621388	2743428	347529	13
17	1400406	1035	247	1657	2291	406114	2004116	347529	13
18	1227249	1048	260	2154	666	536080	476355	347529	13
19	1053680	1061	273	2288	2161	566409	1867858	347529	13
20	1359544	1074	286	2711	2383	669168	2199318	347529	13
21	862468	1087	299	2073	3133	607229	2507537	347529	13
22	905598	1100	312	1813	2135	536742	1690759	347529	13
23	924376	1113	325	1944	2193	512393	1742910	347529	13
24	1467858	1126	338	2754	2033	794019	2109766	347529	13

SHIP-TYPE AMPHIBIOUS OVERALL COMBINED

MONTH	RPC-TOTAL	AGE	TSLOH	SHIN	SHUW	FOIN	FOUW	TOTMDY	#SHIPS
1	2C097C65	827	180	2600	3199	765517	2817271	269413	13
2	16255327	840	193	3341	3094	782326	2452755	269413	13
3	14945712	853	206	2852	2198	606521	1475370	269413	13
4	2C425619	866	206	2740	2545	540641	1743049	267518	13
5	15888368	879	219	2848	1995	51777C	1952857	267518	13
6	1048C978	892	197	1379	817	172415	576634	275893	13
7	15195921	905	210	1552	1852	315989	1507182	275893	13
8	16935894	918	177	2496	2872	547664	1754563	311754	13
9	11232344	931	182	2935	2432	773130	1598227	312322	13
10	25689732	944	195	2558	3800	683303	2638018	312322	13
11	17602429	957	208	2599	3563	92518C	2067821	312322	13
12	1826515C	970	221	2664	1815	8021C4	1592903	312322	13
13	22987101	983	234	3198	2148	89C414	1589895	312322	13
14	27548515	996	247	2842	2923	8317C3	1979934	312322	13
15	23164426	1009	260	3791	2329	887368	1998778	312322	13
16	20078611	1022	234	2262	2778	621388	2743428	347529	13
17	21C98C99	1035	247	1657	2291	406114	2004116	347529	13
18	18566377	1048	260	2154	666	536C8C	476355	347529	13
19	16178644	1061	273	2288	2161	5664C9	1867858	347529	13
20	24823573	1074	286	2711	2383	669168	2199318	347529	13
21	19879512	1087	299	2073	3133	607229	2507537	347529	13
22	15847185	1100	312	1813	2135	536742	1690759	347529	13
23	24766282	1113	325	1944	2193	512393	1742910	347529	13
24	22319775	1126	338	2754	2033	794C19	21C9766	347529	13

SHIP-TYPE CRUISERS APA

MONTH	RPC-APA	AGE	TSLOH	SHIN	SHUW	FCIN	FCLW	TOTMDY	#SHIPS
1	33275694	1506	138	2356	1266	784869	1243569	519869	7
2	27150689	1513	145	2907	1453	920834	1915708	519869	7
3	19364400	1520	152	1376	2122	264195	3263116	519869	7
4	21035440	1527	159	1406	1620	397336	1830222	519869	7
5	21740793	1534	166	2317	916	688240	906543	519869	7
6	15879296	1541	173	1359	823	506439	909722	519869	7
7	16945992	1548	180	1830	1015	738935	1227237	519869	7
8	20025189	1555	187	1536	1768	398216	2698914	519869	7
9	18793145	1562	194	2460	1040	652230	1164886	519869	7
10	15896044	1569	146	1753	1188	515729	930916	521522	7
11	24342090	1576	153	1616	1514	449264	1575815	521522	7
12	18831681	1583	160	935	1281	205252	975405	521522	7
13	24513699	1590	167	2247	1467	506108	1885824	521522	7
14	25813490	1597	174	1754	1124	525208	951941	521522	7
15	28983191	1604	153	2144	1053	642913	845993	755763	7
16	25773465	1611	124	2323	1323	753218	1236377	815888	7
17	31432380	1618	131	1437	1545	429137	1383799	815888	7
18	32814280	1625	138	1710	1311	386236	1623202	815888	7
19	29543446	1632	145	2098	1269	549111	1632268	815888	7
20	33333484	1639	152	2344	1835	829093	1981569	815888	7
21	34024344	1646	103	1774	1204	589818	1588956	804819	7
22	34841630	1653	110	1183	2418	339396	1434469	804819	7
23	41697884	1660	117	1062	2869	321786	1978714	804819	7
24	26699388	1667	124	1636	2135	619665	1559398	804819	7

SHIP-TYPE CRUISERS NSA

MONTH	RPC-NSA	AGE	TSLCH	SHIN	SHUW	FCIN	FCUW	TOTMCY	#SHIPS
1	23214493	1506	138	2356	1266	784869	1243569	519869	7
2	17593790	1513	145	2907	1453	920834	1915708	519869	7
3	16946225	1520	152	1376	2122	264195	3263116	519869	7
4	14292402	1527	159	1406	1620	397336	1830222	519869	7
5	17328033	1534	166	2317	916	68824C	9C6543	519869	7
6	16725361	1541	173	1359	823	506439	9C9722	519869	7
7	14885490	1548	180	1830	1015	738935	1227237	519869	7
8	18171458	1555	187	1536	1768	398216	2698914	519869	7
9	17952135	1562	194	2460	104C	65223C	1164886	519869	7
10	17207842	1569	146	1753	1188	515729	930916	521522	7
11	19045127	1576	153	1616	1514	449264	1575815	521522	7
12	12587936	1583	160	935	1281	205252	975405	521522	7
13	19209943	1590	167	2247	1467	506108	1885824	521522	7
14	16614932	1597	174	1754	1124	5252C8	951941	521522	7
15	18014736	1604	153	2144	1053	642913	845993	755763	7
16	16796129	1611	124	2323	1323	753218	1236377	815888	7
17	19122907	1618	131	1437	1545	429137	1383799	815888	7
18	13820851	1625	138	1710	1311	386236	1623202	815888	7
19	19234017	1632	145	2098	1269	549111	1632268	815888	7
20	16835049	1639	152	2344	1835	829093	1981569	815888	7
21	19456596	1646	103	1774	1204	589818	1588956	804819	7
22	22773883	1653	110	1183	2418	339396	1434469	804819	7
23	27529890	1660	117	1062	2869	321786	1978714	804819	7
24	15374407	1667	124	1636	2135	619665	1559398	804819	7

SHIP-TYPE CRUISERS OTHER

MONTH	RPC-OTHER	AGE	TSLOH	SHIN	SHUW	FCIN	FCUW	TOTMDY	#SHIPS
1	2464C93	15C6	138	2356	1266	784869	1243569	519869	7
2	1999244	1513	145	2907	1453	92C834	1915708	519869	7
3	1866C54	1520	152	1376	2122	264195	3263116	519869	7
4	2444969	1527	159	14C6	162C	397336	1830222	519869	7
5	3572413	1534	166	2317	916	68824C	906543	519869	7
6	2786814	1541	173	1359	823	506439	909722	519869	7
7	1259C87	1548	180	1830	1015	738935	1227237	519869	7
8	2402654	1555	187	1536	1768	398216	2698914	519869	7
9	3823524	1562	194	2460	104C	652230	1164886	519869	7
10	1441601	1569	146	1753	1188	515729	930916	521522	7
11	3461920	1576	153	1616	1514	449264	1575815	521522	7
12	1890176	1583	160	935	1281	205252	975405	521522	7
13	3018195	1590	167	2247	1467	506108	1885824	521522	7
14	1962980	1597	174	1754	1124	5252C8	951941	521522	7
15	1722222	16C4	153	2144	1053	642913	845993	755763	7
16	2184232	1611	124	2323	1323	753218	1236377	815888	7
17	2809C23	1618	131	1437	1545	429137	1383799	815888	7
18	1887277	1625	138	1710	1311	386236	1623202	815888	7
19	1628627	1632	145	2098	1269	549111	1632268	815888	7
20	342C814	1639	152	2344	1835	829C93	1981569	815888	7
21	2231249	1646	103	1774	1204	589818	1588956	8C4819	7
22	23C248C	1653	110	1183	2418	339396	1434469	8C4819	7
23	3208598	1660	117	1062	2869	321786	1978714	8C4819	7
24	2314723	1667	124	1636	2135	619665	1559398	8C4819	7

SHIP-TYPE CRUISERS OVERALL COMBINED

MONTH	RPC-TOTAL	AGE	TSLOH	SHN	SHUW	FCIN	FCUW	TOTMDY	#SHIPS
1	5895828C	15C6	138	2356	1266	784869	1243569	519869	7
2	46743723	1513	145	2907	1453	920834	1915708	519869	7
3	3817667S	1520	152	1376	2122	264195	3263116	519869	7
4	37772811	1527	159	1406	1620	397336	1830222	519869	7
5	42641239	1534	166	2317	916	68824C	906543	519869	7
6	35391471	1541	173	1359	823	506439	909722	519869	7
7	3309C569	1548	180	1830	1015	738935	1227237	519869	7
8	4059S3C1	1555	187	1536	1768	398216	2658914	519869	7
9	4C5688C4	15E2	194	2460	104C	65223C	1164886	519869	7
1C	34545487	1569	146	1753	1188	515729	93C916	521522	7
11	4684S137	1576	153	1616	1514	449264	1575815	521522	7
12	333C9793	1583	16C	935	1281	205252	975405	521522	7
13	46741837	1590	167	2247	1467	5061C8	1885824	521522	7
14	44391402	1597	174	1754	1124	5252C8	951941	521522	7
15	4872C149	1604	153	2144	1053	642913	845993	755763	7
16	44753826	1611	124	2323	1323	753218	1236377	815888	7
17	53364310	1618	131	1437	1545	429137	1383799	815888	7
18	48522408	1625	138	1710	1311	386236	1623202	815888	7
19	504C6C9C	1632	145	2098	1269	549111	1632268	815888	7
2C	53585247	1639	152	2344	1835	829093	1981569	815888	7
21	55712189	1646	103	1774	12C4	589818	1588956	8C4819	7
22	59917993	1653	110	1183	2418	339396	1434469	8C4819	7
23	72436372	1660	117	1062	2869	321786	1978714	8C4819	7
24	44388518	1667	124	1636	2135	619665	1559398	8C4819	7

SHIP-TYPE DESTROYERS APA

MONTH	RPC-APA	AGE	TSLOH	SHIN	SHLW	FCIN	FCUW	TCTMCY	#SHIPS
1	146888565	11321	1970	17805	19172	3431924	14714917	24C7018	98
2	139019596	11417	1975	17649	23335	38C9935	1514C798	2504894	98
3	15C94116C	11515	1930	15169	22449	2838675	16816789	2366965	98
4	160918555	11613	1903	17739	22038	3619220	14771355	2527781	98
5	133287457	11711	1990	13360	16792	2701159	11741925	253184C	98
6	135003857	118C9	2000	10466	12404	2016265	6677111	2552906	98
7	141C19606	119C7	2013	11780	16223	2785C97	9325965	2556413	98
8	153343899	12005	2015	10940	17255	2113140	11993747	2584199	98
9	17646C7C1	12103	1928	13942	17612	3340983	11756285	2447921	98
10	178C96174	12201	1883	14583	19187	3222CC6	14088123	2284921	98
11	13907C121	12299	1822	13535	17359	3140636	12643173	2337210	98
12	144569C66	12397	1594	15381	21056	4478543	16428635	2361568	98
13	182396878	12495	1602	15810	23603	4083180	19971112	2388088	98
14	179936273	12593	1643	15258	21334	4150793	17740150	2274147	98
15	176336108	12691	1577	14947	20734	4151087	17158247	2272204	98
16	151872408	12789	1604	14704	23241	3816871	21219940	2261757	98
17	175348379	12887	1660	13438	22727	3189222	19034340	2271746	98
18	159263C12	12985	1599	9691	15931	2287965	13945C82	2326075	98
19	198331908	13083	1654	10646	18479	2624280	14493575	2320657	98
20	205332835	13181	1715	13746	22972	3736C93	20356343	2334425	98
21	216098085	13279	1813	12161	22879	3806397	20627566	2334425	98
22	205269258	13377	1802	9519	23496	2818171	20692555	2362633	98
23	21785884C	13475	1733	10010	24179	2661909	22656044	2367254	98
24	167128365	13573	1726	14057	25929	3884288	23167461	2424746	98

SHIP-TYPE DESTROYERS NSA

MONTH	RPC-NSA	AGE	TSLOH	SHIN	SHUW	FCIN	FCLW	TCTMDY	#SHIPS
1	103581121	11321	1970	17805	19172	3431924	14714917	2407018	98
2	99C713C1	11417	1975	17649	23335	38C9935	15140798	2504894	98
3	102592241	11515	1930	15169	22449	2838675	16816789	2386969	98
4	11C228C63	11613	1903	17739	22038	3619220	14771355	2527781	98
5	1C3860411	11711	1990	13360	16792	2701159	11741925	253184C	98
6	97966C70	11809	2000	1C466	12404	2016265	6677111	2552906	98
7	116189142	11907	2013	11780	16223	2785C97	9325965	2556413	98
8	9871C857	12005	2015	10940	17255	211314C	11993747	2584199	98
9	11916927E	12103	1928	13942	17612	334C983	11756285	2447921	98
1C	1168C647C	12201	1883	14583	19187	3222006	14088123	2284921	98
11	95538479	12299	1822	13535	17359	3140636	12643173	233721C	98
12	1016643E8	12397	1594	15381	21056	4478543	16428635	2361568	98
13	13420919E	12495	1602	15810	23603	40831EC	19971112	2388088	98
14	126154562	12593	1643	15258	21334	415C793	17740150	2274147	98
15	121658494	12691	1577	14947	20734	4151C87	17158247	2272204	98
16	112742278	12789	1604	14704	23241	3816871	21219940	2261757	98
17	11141C588	12887	166C	13438	22727	3189222	19034340	2271746	98
18	98964476	12985	1599	9691	15931	2287965	13945C82	2326C75	98
19	125904489	13083	1654	10646	18479	26242EC	14493575	2320657	98
2C	121517C87	13181	1715	13746	22972	3736C93	20356343	2334425	98
21	119397C92	13279	1813	12161	22879	3806397	20627566	2334425	98
22	131371762	13377	1802	9519	23496	2818171	20692555	2362633	98
23	149392993	13475	1733	10C10	24179	2661909	22656C44	2367254	98
24	93074778	13573	1726	14057	25929	3884288	23167461	2424746	98

SHIP-TYPE DESTROYERS OTHER

MONTH	RPC-OTHER	AGE	TSLOH	SHIN	SHUW	FCIN	FCUW	TOTMDY	#SHIPS
1	73C485C	9918	1724	16990	17353	3298183	13941510	23C0734	89
2	8249556	10005	1761	16778	20818	3725278	14325374	2392830	89
3	8762092	10094	1707	14703	21019	276C519	15961836	2274905	89
4	6575959	10183	1731	16263	21095	3426346	14030186	228987C	89
5	67C3970	10272	1809	12460	15780	2627679	11069995	2293929	89
6	8092244	10361	1810	10201	11785	1951893	6423911	2314995	89
7	12483962	10450	1862	11071	15400	2617145	9009497	2320714	89
8	10760414	10539	1855	10481	16610	2057347	11556257	2348500	89
9	13194175	10628	1759	13086	16450	3220948	11313786	2212222	89
10	14467868	10717	1705	13454	17862	3090876	13343160	2049222	89
11	1930799C	10806	1635	12707	15990	3010498	11975360	2101511	89
12	19885234	10895	1461	14433	19591	4386460	15555397	2107511	89
13	14914C38	10984	1502	14487	20914	3968636	18766C50	2134328	89
14	17788C8C	11073	1544	14031	18890	3799171	16451149	2147165	89
15	18879253	11162	1469	14200	18610	4019684	16112164	2145222	89
16	12695852	11251	1487	13368	21424	3627097	19929394	2134775	89
17	17445142	11340	1534	12562	20406	3112142	17847462	2144764	89
18	12119293	11429	1507	8451	12987	2198728	12843858	2192848	89
19	10251937	11518	1553	9429	15378	2546283	13502509	218743C	89
20	10026548	11607	1605	12924	20252	3643972	19025259	2201198	89
21	8861193	11696	1694	11009	20489	3631187	19261140	2201198	89
22	11054469	11785	1674	8989	20784	2727076	19550871	2229406	89
23	12515311	11874	1596	9011	22093	2499397	21553539	2234027	89
24	12429654	11963	1580	13075	22819	3692286	21738207	2291519	89

SHIP-TYPE DESTROYERS OVERALL COMBINED

MONTH	RPC-TOTAL	AGE	TSLOH	SHIN	SHUW	FOIN	FOLW	TOTMDY	#SHIPS
1	249900302	9918	1724	16990	17353	3298183	13941510	2300734	89
2	235477802	10005	1761	16778	20818	3725278	14325374	2392830	89
3	250471108	10094	1707	14703	21019	2760519	15961836	2274905	89
4	264904467	10183	1731	16263	21095	3426346	14030186	2285870	89
5	236510818	10272	1809	12460	15780	2627679	11069995	2293929	89
6	231046136	10361	1810	10201	11785	1951893	6423911	2314995	89
7	260713326	10450	1862	11071	15400	2617145	9009497	2320714	89
8	254906741	10539	1855	10481	16610	2057347	11556257	2348500	89
9	296339527	10628	1759	13086	16450	3220948	11313786	2212222	89
10	298772524	10717	1705	13454	17862	3090876	13343160	2049222	89
11	243745324	10806	1635	12707	15990	3010498	11975360	2101511	89
12	261557615	10895	1461	14433	19591	4386460	15555397	2107511	89
13	317369011	10984	1502	14487	20914	3968636	18766050	2134328	89
14	309461932	11073	1544	14031	18890	3799171	16451149	2147165	89
15	305130414	11162	1469	14200	18610	4019684	16112164	2145222	89
16	266395317	11251	1487	13368	21424	3627097	19929394	2134775	89
17	284776872	11340	1534	12562	20406	3112142	17847462	2144764	89
18	260371903	11429	1507	8451	12987	2198728	12843858	2192848	89
19	321640906	11518	1553	9429	15378	2546283	13502509	2187430	89
20	313563864	11607	1605	12924	20252	3643972	19025259	2201198	89
21	328589594	11696	1694	11009	20489	3631187	19261140	2201198	89
22	330245884	11785	1674	8989	20784	2727076	19550871	2229406	89
23	369132938	11874	1596	9011	22093	2499397	21553539	2234027	89
24	261477449	11963	1580	13075	22819	3692286	21738207	2291519	89

SHIP-TYPE SUBMARINES APA

MONTH	RPC-APA	AGE	TSLOH	SHIN	SHLW	FCIN	FCLW	TOTMOY	#SHIPS
1	48983680	4518	1578	2806	11406	42917	212377	6931565	45
2	54542853	4563	1540	4729	13803	36076	255247	7280996	45
3	58591025	4608	1548	3720	14985	25120	293159	7080054	45
4	64868750	4653	1593	1661	14607	38274	156250	7080054	45
5	49010081	4698	1570	1305	13332	63928	169638	7335054	45
6	50301662	4743	1493	822	12128	29676	66735	7372151	45
7	62912765	4788	1530	1542	11657	40548	110424	6845141	45
8	46778836	4833	1420	1198	13984	39143	373648	6770226	45
9	54288585	4878	1465	1230	13589	42132	195244	6770226	45
10	52021452	4923	1397	1331	13132	32675	191475	6766382	45
11	55300547	4968	1407	996	14495	32662	217510	6720095	45
12	57442231	5013	1437	1269	9982	32430	267487	6567173	45
13	54005365	5058	1482	1688	13032	39934	250877	6567173	45
14	58775144	5103	1521	1447	12444	34271	251512	6341953	45
15	57760965	5148	1406	1025	13745	33757	126613	6597678	45
16	50364968	5193	1366	908	13110	43434	100985	6315276	45
17	62338019	5238	1337	784	14563	28445	300549	6052423	45
18	63200017	5283	1382	985	13031	32141	200677	6052423	45
19	72122913	5328	1361	1107	13892	25629	211707	5878068	45
20	56960862	5373	1379	2154	12236	35170	68972	5587553	45
21	67268704	5418	1380	1071	13492	24250	132855	5596053	45
22	64993462	5463	1419	422	14399	18735	102635	5604053	45
23	64109253	5508	1391	1034	16305	33612	47831	5869053	45
24	63253807	5553	1391	1143	16107	28664	87052	5819068	45

SHIP-TYPE SUBMARINES NSA

MONTH	RPC-NSA	AGE	TSLOH	SHIN	SHUW	FCIN	FCUW	TOTMCY	#SHIPS
1	54567222	6180	1795	2942	12474	546C5	250175	7273275	55
2	5684716C	6235	1767	6144	14962	5C112	365C39	7622706	55
3	52981598	6290	175C	3970	17081	3733C	361954	7415353	55
4	5265C321	6345	1805	1972	16777	491CC	218212	7415353	55
5	48941784	64CO	1792	1908	15164	83671	273272	767C353	55
6	50677568	6455	1692	1654	13666	4299C	162260	77C5584	55
7	6221C242	6510	1739	2690	13090	55513	144827	7178574	55
8	46745521	6565	1639	2020	15525	58C33	492C65	71C3659	55
9	57122349	662C	1694	2196	15324	56CC1	274480	71C3659	55
1C	59157581	6675	1636	2082	1595C	521C7	428C46	7C99815	55
11	51192923	6730	1656	1913	16495	47967	391065	7C53528	55
12	599375C6	6785	1661	2304	12539	50CC7	491286	69C581C	55
13	55577319	6840	1716	2655	1496C	73C96	5C2358	69C581C	55
14	52534669	6895	1765	2361	14946	53389	479122	668C590	55
15	496C9375	695C	166C	1819	15507	52C88	323856	6936315	55
16	50CC6299	7005	1630	1657	14672	58791	282474	6653913	55
17	605C3286	7C6C	1611	1196	16467	3976C6	425565	6391060	55
18	65995396	7115	1666	1947	13536	41482	261614	6391C6C	55
19	66277355	7170	1655	1380	14465	41482	274202	6216705	55
2C	5297C612	7225	1683	2375	13723	52266	248861	5926190	55
21	68630383	7280	1694	1293	1498C8	37334	263C29	5934690	55
22	626C274C	7335	1709	13C7	15805	45936	186451	5919827	55
23	68386969	7390	1576	1792	18968	49523	241439	6450384	55
24	5662C50C	7445	1586	1987	18059	566C7	315686	64CC399	55

MONTH	RPC-OTHER	AGE	TSLOH	SHIP-TYPE SUBMARINES OTHER SHIN	SHUW	FCIN	FCUW	TOTMDY	#SHIPS
1	6410C	379	110	410	1017	2C27	970	1369111	5
2	9C325	384	107	144	2785	11C9	1379	138C253	5
3	242721	389	112	265	2078	2C97	1	138C253	5
4	25C297	394	117	184	1748	51C4	1018	138C253	5
5	604868	399	122	183	2872	271C	418	138C253	5
6	379C48	4C4	127	9	2111	628	446	138C253	5
7	2C4CC69	4C9	132	175	2389	558C	422	138C253	5
8	262730	414	137	65	2766	15C5	420	138C253	5
9	165654E	419	142	44	215C	1315	280	138C253	5
1C	13326C1	424	147	62	2241	291C	812	138C253	5
11	462C40	429	152	39	278C	139C	817	138C253	5
12	85C516	434	157	36	475	86C	75	138C253	5
13	486310	439	162	92	2181	3166	833	138C253	5
14	739558	444	167	94	265C	3694	1100	138C253	5
15	242557	449	172	30	2651	355	722	138C253	5
16	368C36	454	177	114	2233	4C13	1C54	138C253	5
17	546227	459	182	50	2894	181C	1C11	138C253	5
18	553377	464	187	33	2155	993	305	138C253	5
19	84432C	469	192	198	2407	6467	705	138C253	5
2C	998206	474	197	37	2702	695	1362	138C253	5
21	3C7774	479	202	146	2312	1968	1565	138C253	5
22	363565	484	207	51	2074	2738	2363	138C253	5
23	1C3897C	489	212	35	302C	1212	1C41	138C253	5
24	19C673	494	217	39	2171	1228	656	1380253	5

SHIP-TYPE SUBMARINES OVERALL COMBINED

MONTH	RPC-TOTAL	AGE	TSLOH	SHIN	SHUW	FOIN	FOLW	TOTMDY	#SHIPS
1	28987088	379	110	410	1017	2027	970	1369111	5
2	15483934	384	107	144	2785	1109	1379	1380253	5
3	2173467C	389	112	265	2078	2097	1	1380253	5
4	277CC905	394	117	184	1748	5104	1018	1380253	5
5	14757730	399	122	183	2872	3710	418	1380253	5
6	18981934	404	127	9	2111	628	446	1380253	5
7	30689350	409	132	175	2389	5580	422	1380253	5
8	14521993	414	137	65	2766	1505	420	1380253	5
9	21523603	419	142	44	2150	1315	280	1380253	5
10	20221154	424	147	62	2241	2910	812	1380253	5
11	19214173	429	152	39	2780	1390	817	1380253	5
12	27543311	434	157	36	475	860	75	1380253	5
13	22514846	439	162	92	2181	3166	833	1380253	5
14	25427571	444	167	94	2650	3694	1100	1380253	5
15	23597115	449	172	30	2651	355	722	1380253	5
16	2113C977	454	177	114	2233	4013	1054	1380253	5
17	22489876	459	182	50	2894	1810	1011	1380253	5
18	28576969	464	187	33	2155	993	305	1380253	5
19	32335351	469	192	198	2407	6467	705	1380253	5
20	13666C60	474	197	37	2702	695	1362	1380253	5
21	17745726	479	202	146	2312	1968	1565	1380253	5
22	262C1259	484	207	51	2074	2738	2363	1380253	5
23	21C11245	489	212	35	3020	1212	1041	1380253	5
24	1354C493	494	217	39	2171	1228	656	1380253	5

SHIP-TYPE UNDERWAY REPLENISHMENT APA

MONTH	RPC-APA	AGE	TSLOH	SHIN	SHLH	FCIN	FCLW	TCTMCY	#SHIPS
1	3962C50	1820	197	3159	2555	694335	158C383	521973	12
2	4161550	1832	175	2889	1881	695554	839784	543341	12
3	5265498	1844	185	3493	2165	803982	1255562	237338	12
4	3725ECC	1856	197	25C8	25C6	64C518	2285337	237338	12
5	14657CC	1868	209	1764	2528	4021C8	1746C61	237338	12
6	4C74C66	1880	221	3500	1162	664552	754503	237338	12
7	1537CCC	1892	233	3721	2436	795726	1428213	237338	12
8	5733263	19C4	208	2957	3488	636159	2138102	246514	12
9	482845C	1916	220	3699	3036	885736	1869700	246514	12
1C	2671C55	1928	232	3298	2400	76623C	19C2458	246514	12
11	2835319	194C	244	2462	2253	521111	1517384	246514	12
12	3203C64	1952	247	3554	2486	767756	1663000	246957	12
13	6568240	1964	259	3086	286C	82C57C	1589303	246957	12
14	497C25C	1976	271	2915	2626	644162	2335487	246957	12
15	3425E0C	1988	283	3135	3024	788685	2390162	246957	12
16	4753899	2CC0	295	2001	2803	504415	2673616	246957	12
17	6434459	2012	307	2C69	202C	468617	1775448	246957	12
18	2C64250	2C24	319	2508	1512	565505	1468795	246957	12
19	2838200	2036	285	3344	3124	761564	2326C13	27C881	12
2C	5651466	2048	297	2C15	3211	527365	2376839	27C881	12
21	8141535	2060	309	2023	3305	512554	2465C46	27C881	12
22	5626545	2072	321	2612	2752	594C67	2228590	27C881	12
23	2414700	2084	333	1857	3581	445182	2582294	27C881	12
24	5657445	2096	345	1509	3785	33721C	3472456	27C881	12

SHIP-TYPE UNDERWAY REPLENISHMENT NSA

MONTH	RPC-NSA	AGE	TSLOH	SHIN	SHUW	FCIN	FCUW	TOTMDY	#SHIPS
1	8007516	3128	361	5162	3069	772576	1805339	6C0124	18
2	9305205	3146	345	3625	3013	771239	1378872	621492	18
3	9399237	3164	361	4492	2822	867772	1761483	315489	18
4	9758270	3182	379	3926	3423	70C783	2548870	315489	18
5	7942361	32C0	358	3556	301C	534294	1973398	32C841	18
6	6368738	3218	293	5C99	1814	821C37	1C18786	337293	18
7	7226737	3236	311	5602	3858	980937	189C961	337293	18
8	7125CC1	3254	292	5063	5087	79361C	2037467	346469	18
9	8585763	3272	31C	4941	4423	94283C	2805544	346469	18
1C	679C051	3290	328	4599	4368	913979	3223427	346469	18
11	6587389	3308	346	3895	424C	757352	2434046	346469	18
12	7C9C821	3326	355	4825	36C8	897851	2410C36	346952	18
13	56CCC54	3344	373	3798	3621	909536	2647422	346952	18
14	6286957	3362	391	3982	3943	7768C1	2984419	346952	18
15	8449593	338C	409	4312	3458	846264	2434338	346952	18
16	9350374	3398	427	2861	4149	66716C	3127746	346952	18
17	9772972	3416	383	2938	3085	61269C	2435227	358112	18
18	5370243	3434	401	3385	1932	658625	1675951	358112	18
19	69C7444	3452	373	4175	374C	871C32	2571793	381996	18
2C	8554590	3470	391	3028	4663	715543	3137596	381996	18
21	7456327	3488	409	2865	4914	654222	3218312	381996	18
22	6264CC9	35C6	427	3464	407C	690265	3048214	381996	18
23	6815557	3524	445	2969	528C	625788	3771108	381996	18
24	1C256714	3542	463	2644	5062	488459	4580548	381996	18

SHIP-TYPE UNDERWAY REPLENISHMENT OTHER

MONTH	RPC-OTHER	AGE	TSLOH	SHIN	SHOW	FOIN	FOLW	TOTMOY	#SHIPS
1	639455	1907	204	2538	2331	564373	1436675	468836	12
2	600970	1919	182	3052	2521	672520	1311244	490204	12
3	999924	1931	192	3384	2690	802510	1657294	184201	12
4	614305	1943	204	3096	2718	673869	2088838	184201	12
5	352300	1955	216	2112	2827	459548	1930020	184201	12
6	505824	1967	185	3289	1328	654062	834156	190654	12
7	746589	1979	197	4005	2295	840529	1347502	190654	12
8	745502	1991	209	2910	3906	594247	2323385	190654	12
9	1546163	2003	221	3354	2399	811967	1485685	190654	12
10	314148	2015	233	3546	2942	822204	2312623	190654	12
11	440591	2027	245	2322	1915	476802	1341153	190654	12
12	1047702	2039	248	2901	2231	627265	1471174	191137	12
13	1002607	2051	260	2489	2468	636244	1739972	191137	12
14	788247	2063	272	2388	2699	534618	2380730	191137	12
15	1870129	2075	284	2617	2153	623617	1781984	191137	12
16	1273312	2087	296	2110	2647	522083	2369136	191137	12
17	1210562	2099	308	2193	2638	481823	2288832	191137	12
18	586417	2111	320	2071	1644	522402	1581614	191137	12
19	1096539	2123	286	3375	2824	787700	2238534	215021	12
20	812596	2135	298	2008	3043	502922	2199272	215021	12
21	809003	2147	310	2139	3756	528626	2792251	215021	12
22	551503	2159	322	2318	3053	567904	2304436	215021	12
23	375119	2171	334	2191	3273	499624	2304120	215021	12
24	1147731	2183	346	1859	4045	418246	3606311	215021	12

UNDERWAY REPLENISHMENT OVERALL COMBINED

MONTH	RPC-TOTAL	AGE	TSLOH	SHIN	SHUW	FCIN	FCUW	TOTMDY	#SHIPS
1	8460652	1432	163	2297	2099	508942	1242296	449220	10
2	9102092	1442	139	2593	1879	600184	837934	470588	10
3	11868704	1452	147	3105	2033	745067	1195773	164585	10
4	9481083	1462	157	2816	2254	622720	1837303	164585	10
5	5857084	1472	167	1697	2512	392538	1734192	164585	10
6	8658075	1482	177	2625	1056	536458	664816	164585	10
7	7034359	1492	187	3286	1850	716295	1085039	164585	10
8	10529692	1502	197	2335	3133	512688	1782415	164585	10
9	10533431	1512	207	3296	2113	796823	1264190	164585	10
10	6829961	1522	217	3150	2110	732468	1669578	164585	10
11	6270139	1532	227	1947	1611	409067	1083210	164585	10
12	7079492	1542	228	2739	2119	594906	1381902	165068	10
13	9986828	1552	238	2462	2325	623936	1625049	165068	10
14	8406362	1562	248	2182	2102	474332	1933168	165068	10
15	9961341	1572	258	2575	2144	616907	1775045	165068	10
16	9183246	1582	268	1762	2320	451798	2154165	165068	10
17	12053426	1592	278	1952	1930	433362	1713484	165068	10
18	5698747	1602	288	1887	1402	479179	1405510	165068	10
19	7689964	1612	252	3119	2589	726015	2055172	188952	10
20	10118700	1622	262	1721	2427	440439	1800331	188952	10
21	12439385	1632	272	1858	3123	471885	2322732	188952	10
22	8200464	1642	282	1998	2464	505603	1974593	188952	10
23	7383329	1652	292	1655	2646	395459	1969729	188952	10
24	11673466	1662	302	1418	3644	316232	3336132	188952	10

APPENDIX F

DATA COMPILATION PROGRAM

```
IDENTIFICATION DIVISION.
PROGRAM-ID. 'PNCHOUT1'.
ENVIRONMENT DIVISION.
CONFIGURATION SECTION.
SOURCE-COMPUTER. IBM-360-67.
OBJECT-COMPUTER. IBM-360-67.
INPUT-OUTPUT SECTION.
FILE-CONTROL.
    SELECT MASTER-FILE ASSIGN TO 'TAPIN' UTILITY.
    SELECT CARDOUT-FILE ASSIGN TO 'CARDOUT' UTILITY.
DATA DIVISION.
FILE SECTION.
FD  MASTER-FILE
    RECORD CONTAINS 9510 CHARACTERS
    DATA RECORD IS MASTER-RECORD
    RECORDING MODE IS F
    LABEL RECORDS ARE STANDARD.
01  MASTER-RECORD.
    02  SHIP-CLASS1              PICTURE X.
    02  SHIP-CLASS2              PICTURE X.
    02  FILLER                   PICTURE X(26).
    02  HOMEPORT                 PICTURE X(5).
    02  OCEAN                    PICTURE X(1).
    02  COMMDATE                 PICTURE X(4).
    02  RPC-CODE                 PICTURE X(1).
    02  FC-CODE                  PICTURE X.
    02  CH-CODE                  PICTURE X.
    02  FILLER                   PICTURE X(13).
    02  MONTHLY-INF OCCURS 24 TIMES.
        03  FILLER               PICTURE X(2).
        03  TSLOH                PICTURE 9(3).
        03  MANDAYS-INFO OCCURS 6 TIMES.
            04  MANDAYS          PICTURE 9(7).
        03  SHIN                 PICTURE 9(3).
        03  SHUW                 PICTURE 9(3).
        03  FCIN                 PICTURE 9(8).
        03  FCUW                 PICTURE 9(8).
        03  INOH                 PICTURE X(1).
        03  AGE                  PICTURE 9(3).
        03  FILLER               PICTURE X(294).
        03  RPC-APA              PICTURE 9(9).
        03  RPC-NSA              PICTURE 9(9).
        03  RPC-OTHER            PICTURE 9(9).
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FD   CARDOUT-FILE
     RECORD CONTAINS 80 CHARACTERS
     RECORDING MODE IS F
     LABEL RECORDS ARE STANDARD
     DATA RECORDS ARE CARDSOUT1 CARDSOUT2 CARDSOUT3.
01   CARDSOUT1.
     02   MONTH1                    PICTURE X(2).
     02   CRPC-TOTAL                PICTURE 9(13).
     02   CRPC-APA                  PICTURE 9(12).
     02   CRPC-NSA                  PICTURE 9(12).
     02   CRPC-OTHER                PICTURE 9(12).
     02   CAGE                      PICTURE 9(6).
     02   CTSLCH                    PICTURE 9(6).
     02   FILLER                    PICTURE X(16).
     02   CARD1                     PICTURE X(1).
01   CARDSOUT2.
     02   MONTH2                    PICTURE 9(2).
     02   CSHIN                     PICTURE 9(6).
     02   CSHUW                     PICTURE 9(6).
     02   CFCIN                     PICTURE 9(11).
     02   CFCUW                     PICTURE 9(11).
     02   FILLER                    PICTURE X(43).
     02   CARD2                     PICTURE X(1).
01   CARDSOUT3.
     02   MONTH3                    PICTURE X(2).
     02   CMANDAYS-INFO OCCURS 6 TIMES.
          03   CMANDAYS             PICTURE 9(10).
     02   FILLER                    PICTURE X(10).
     02   SHIPS                     PICTURE X(3).
     02   FILLER                    PICTURE X(4).
     02   CARD3                     PICTURE X(1).
WORKING-STORAGE SECTION.
77   L                              PICTURE 99 VALUE 1.
77   J                              PICTURE 99 VALUE 1.
77   K                              PICTURE 99 VALUE 1.
77   M                              PICTURE 999 VALUE 1.
77   N                              PICTURE 999 VALUE 0.
01   SUMMARY-INFO.
     02   MONTHLY-INFO OCCURS 24 TIMES.
          03   WMONTH               PICTURE 9(2).
          03   WRPC-TOTAL           PICTURE 9(13).
          03   WRPC-APA             PICTURE 9(12).
          03   WRPC-NSA             PICTURE 9(12).
          03   WRPC-OTHER           PICTURE 9(12).
          03   TOTAL      PICTURE 9(13).
          03   WAGE                 PICTURE 9(6).
          03   WTSLCH               PICTURE 9(6).
          03   WSHIN                PICTURE 9(6).
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           03  WSHUW                  PICTURE 9(6).
           03  WFCIN                  PICTURE 9(11).
           03  WFCUW                  PICTURE 9(11).
           03  WMANDAYS-INFO OCCURS 6 TIMES.
               04  WMANDAYS PICTURE 9(10).
PROCEDURE DIVISION.
    OPEN INPUT MASTER-FILE.
    OPEN OUTPUT CARDOUT-FILE.
    MOVE ZERO TO SUMMARY-INFO.
READ-TAPE.
    READ MASTER-FILE AT END GO TO END-OF-FILE.
    IF SHIP-CLASS1 NOT EQUAL TO 'A' GO TO READ-TAPE.
    IF SHIP-CLASS2 EQUAL TO 'D' GO TO READ-TAPE.
    IF SHIP-CLASS2 EQUAL TO 'G' GO TO READ-TAPE.
    IF SHIP-CLASS2 EQUAL TO 'R' GO TO READ-TAPE.
    IF SHIP-CLASS2 EQUAL TO 'S' GO TO READ-TAPE.
    IF SHIP-CLASS2 EQUAL TO 'T' GO TO READ-TAPE.
    IF FC-CODE EQUAL TO ZERO GO TO READ-TAPE.
    IF RPC-CODE EQUAL TO 'G' GO TO COMPUTE-FILE.
    IF RPC-CODE EQUAL TO 'B' GO TO COMPUTE-FILE.
    IF RPC-CODE EQUAL TO 'A' GO TO COMPUTE-FILE.
    IF RPC-CODE EQUAL TO 'C' GO TO COMPUTE-FILE.
    GO TO READ-TAPE.
COMPUTE-FILE.
    ADD RPC-APA (M) TO WRPC-APA (M).
    ADD RPC-NSA (M) TO WRPC-NSA (M).
    ADD RPC-OTHER (M) TO WRPC-OTHER (M).
    ADD RPC-APA (M) RPC-NSA (M) RPC-OTHER (M) GIVING TOTAL (M).
    ADD TOTAL (M) TO WRPC-TOTAL (M).
    ADD AGE (M) TO WAGE (M).
    ADD TSLOH (M) TO WTSLOH (M).
    ADD SHIN (M) TO WSHIN (M).
    ADD SHUW (M) TO WSHUW (M).
    ADD FCIN (M) TO WFCIN (M).
    ADD FCUW (M) TO WFCUW (M).
MANDAYS-IN.
    ADD MANDAYS (M, L) TO WMANDAYS (M, L).
    ADD 1 TO L.
    IF L LESS THAN 7 GO TO MANDAYS-IN.
    MOVE 1 TO L.
CHECK-CH.
    ADD 1 TO M.
    IF M LESS THAN 25 GO TO COMPUTE-FILE.
    MOVE 1 TO M.
    ADD 1 TO N.
    GO TO READ-TAPE.
END-OF-FILE.
    MOVE SPACE TO CARDSOUT1.
```

```
            MOVE 1 TO CARD1.
            MOVE K TO MONTH1.
            MOVE WRPC-TOTAL (K) TO CRPC-TOTAL.
            MOVE WRPC-APA (K) TO CRPC-APA.
            MOVE WRPC-NSA (K) TO CRPC-NSA.
            MOVE WRPC-OTHER (K) TO CRPC-OTHER.
            MOVE WAGE (K) TO CAGE.
            MOVE WTSLOH (K) TO CTSLOH.
            WRITE CARDSOUT1.
            MOVE SPACE TO CARDSOUT1.
            MOVE 2 TO CARD2.
            MOVE K TO MONTH2.
            MOVE WSHIN (K) TO CSHIN.
            MOVE WSHOW (K) TO CSHOW.
            MOVE WFCIN (K) TO CFCIN.
            MOVE WFCOW (K) TO CFCOW.
            WRITE CARDSOUT2.
            MOVE SPACE TO CARDSOUT1.
            MOVE 3 TO CARD3.
            MOVE K TO MONTH3.
        WRITE-CARDSOUT3.
            MOVE WMANDAYS (K, J) TO CMANDAYS (J).
            ADD 1 TO J.
            IF J LESS THAN 7 GO TO WRITE-CARDSOUT3.
            MOVE 1 TO J.
            MOVE N TO SHIPS.
            WRITE CARDSOUT3.
            ADD 1 TO K.
            IF K LESS THAN 25 GO TO END-OF-FILE.
        END-PROGRAM.
            CLOSE MASTER-FILE CARDOUT-FILE WITH NO REWIND.
            STOP RUN.
//GO.CARDOUT DD SYSOUT=B
//GO.TAPIN DD UNIT=2400,DSNAME=MASTER,LABEL=(,SL,,IN),
//       VOL=SER=NPS253,DISP=(OLD,KEEP)
```

APPENDIX G

FIRST PARTIAL MASTER-OVERHAUL

```
IDENTIFICATION DIVISION.
PROGRAM-ID. 'MASTR1'.
ENVIRONMENT DIVISION.
CONFIGURATION SECTION.
SOURCE-COMPUTER. IBM-360-67.
OBJECT-COMPUTER. IBM-360-67.
INPUT-OUTPUT SECTION.
FILE-CONTROL.
    SELECT MASTER-FILE ASSIGN TO 'TAPOUT' UTILITY.
    SELECT OVERHAUL-FILE ASSIGN TO 'TAPIN' UTILITY.
    SELECT VALID-SHIP-FILE ASSIGN TO 'CARDIN' UTILITY.
DATA DIVISION.
FILE SECTION.
FD  MASTER-FILE
    RECORD CONTAINS 9510 CHARACTERS
    DATA RECORD IS MASTER-RECORD
    RECORDING MODE IS F
    LABEL RECORDS ARE STANDARD.
01  MASTER-RECORD.
    02  SHIP                PICTURE X(8).
    02  NAME                PICTURE X(20).
    02  HOME-PORT           PICTURE X(5).
    02  OCEAN               PICTURE X(1).
    02  COMM-DATE.
        03  COMM-YEAR       PICTURE 9(2).
        03  COMM-MONTH      PICTURE 9(2).
    02  CODES               PICTURE X(3).
    02  MISC                PICTURE X(13).
    02  MONTHLY-INFO OCCURS 24 TIMES.
        03  TYPE-AVAIL      PICTURE X(2).
        03  LAST-OH         PICTURE 9(3).
        03  MANDAYS-INFO OCCURS 6 TIMES.
            04  MANDAYS     PICTURE X(7).
        03  SHIN            PICTURE X(3).
        03  SHOUT           PICTURE X(3).
        03  FOIN            PICTURE X(8).
        03  FOOUT           PICTURE X(8).
        03  INOH            PICTURE X(1).
        03  AGE             PICTURE 9(3).
        03  EICS OCCURS 14 TIMES.
            04  APA         PICTURE 9(7).
            04  NSA         PICTURE 9(7).
            04  OTHER       PICTURE 9(7).
```

```
           03  APA-TOT      PICTURE 9(9).
           03  NSA-TOT      PICTURE 9(9).
           03  OTHER-TOT    PICTURE 9(9).
FD  OVERHAUL-FILE
    BLOCK CONTAINS 10 RECORDS
    RECORD CONTAINS 312 CHARACTERS
    DATA RECORD IS OVERHAUL-RECORD
    RECORDING MODE IS F
    LABEL RECORDS ARE STANDARD.
01  OVERHAUL-RECORD.
    02  FILLER              PICTURE X(1).
    02  SHIP-ID             PICTURE X(8).
    02  FILLER              PICTURE X(6).
    02  SHIP-NAME           PICTURE X(20).
    02  SHIP-PORT           PICTURE X(5).
    02  FILLER              PICTURE X(10).
    02  OC                  PICTURE X(1).
    02  FILLER              PICTURE X(104).
    02  START-DATE          PICTURE 9(4).
    02  FILLER PICTURE X(2).
    02  FINISH-DATE         PICTURE 9(4).
    02  FILLER              PICTURE X(26).
    02  COMMIS-DATE         PICTURE 9(4).
    02  FILLER              PICTURE X(117).
FD  VALID-SHIP-FILE
    RECORD CONTAINS 80 CHARACTERS
    RECORDING MODE IS F
    LABEL RECORDS ARE STANDARD
    DATA RECORD IS VALID-SHIP-CARD.
01  VALID-SHIP-CARD.
    02  VALID-INFO          PICTURE X(11).
    02  FILLER              PICTURE X(69).
WORKING-STORAGE SECTION.
77  M                       PICTURE 999 VALUE 1.
77  N                       PICTURE 999 VALUE 1.
77  L                       PICTURE 999 VALUE 0.
77  SHIP-HOLD               PICTURE X(8).
77  END-OF-SHIP             PICTURE 9 VALUE 0.
77  EOF-SWITCH              PICTURE 9 VALUE 0.
77  COMM-DATE-MONTHS        PICTURE 999.
77  LOH-DATE-MONTHS         PICTURE 999.
77  MONTHS-AGE PICTURE 999 VALUE 847.
77  LETTER                  PICTURE X.
01  LAST-OVERHAUL-RECORD.
    02  FILLER              PICTURE X(12).
    02  TA                  PICTURE X(2).
    02  FILLER              PICTURE X(147).
    02  LOH-DATES.
```

```
           03  LOH-YEAR     PICTURE 99.
           03  LOH-MONTH    PICTURE 99.
       02  FILLER           PICTURE X(36).
       02  MANDAYS-INF OCCURS 6 TIMES.
           03  FILLER       PICTURE X(3).
           03  DAYS.
               04  FILLER   PICTURE X(6).
               04  M-LETT   PICTURE X(1).
       02  FILLER           PICTURE X(51).
   01  VALID-SHIP-TABLE.
       02  VALID-SHIPS OCCURS 475 TIMES.
           03  VALID-SHIP   PICTURE X(8).
           03  CODS         PICTURE X(3).
   01  LDAYS.
       02  FILLER           PICTURE X(6).
       02  LLET             PICTURE X(1).
   01  MONTH-DATES.
       02 MONTH OCCURS 24 TIMES PICTURE 9(4).
   01  M-DATES PICTURE X(96) VALUE '7007700870970107011701271017102
  -    '7103710471057106710771087109711071117112720172027203720472057
  -    '7206'.
   PROCEDURE DIVISION.
       OPEN INPUT OVERHAUL-FILE, VALID-SHIP-FILE.
       OPEN OUTPUT MASTER-FILE.
   FILL-TABLE.
       READ VALID-SHIP-FILE AT END GO TO SET-UP.
       MOVE VALID-INFO TO VALID-SHIPS (N).
       ADD 1 TO N.
       GO TO FILL-TABLE.
   SET-UP.
       MOVE ZERO TO VALID-SHIPS (N).
       MOVE M-DATES TO MONTH-DATES.
       READ OVERHAUL-FILE AT END GO TO END-OF-FILE.
       MOVE SHIP-ID TO SHIP-HOLD.
       MOVE 1 TO N.
       GO TO CHECK-SHIP.
   READ-TAPE.
       READ OVERHAUL-FILE AT END GO TO END-OF-FILE.
   CHECK-SHIP.
       IF VALID-SHIP (N) EQUAL TO ZERO GO TO END-PROGRAM.
       IF SHIP-ID EQUAL TO VALID-SHIP (N) GO TO BUILD-MASTER.
       IF SHIP-ID GREATER THAN VALID-SHIP (N)
           ADD 1 TO N
           GO TO CHECK-SHIP.
       GO TO READ-TAPE.
   BUILD-MASTER.
       MOVE SHIP-ID TO SHIP SHIP-HOLD.
       MOVE SHIP-NAME TO NAME.
```

```
    MOVE SHIP-PORT TO HOME-PORT.
    MOVE OC TO OCEAN.
    MOVE COMMIS-DATE TO COMM-DATE.
    MOVE CODS (N) TO CODES.
    MOVE 1 TO M.
    MOVE 847 TO MONTHS-AGE.
    MULTIPLY COMM-YEAR BY 12 GIVING COMM-DATE-MONTHS.
    ADD COMM-MONTH TO COMM-DATE-MONTHS.
CHECK-DATES.
    IF END-OF-SHIP EQUAL TO 1 GO TO LAST-OVERHAUL-INFO.
    IF FINISH-DATE GREATER THAN MONTH (M)
        GO TO LAST-OVERHAUL-INFO.
    MOVE OVERHAUL-RECORD TO LAST-OVERHAUL-RECORD.
    MULTIPLY LOH-YEAR BY 12 GIVING LOH-DATE-MONTHS.
    ADD LOH-MONTH TO LOH-DATE-MONTHS.
    READ OVERHAUL-FILE AT END GO TO END-OF-FILE.
    IF SHIP-ID EQUAL TO SHIP-HOLD GO TO CHECK-DATES.
    MOVE 1 TO END-OF-SHIP.
LAST-OVERHAUL-INFO.
    MOVE TA TO TYPE-AVAIL (M).
    MOVE 1 TO L.
MANDAYS-LETTERS.
    MOVE M-LETT (L) TO LETTER.
    PERFORM LETTER-OUT THRU LETTER-EXIT.
    MOVE DAYS (L) TO LDAYS.
    MOVE LETTER TO LLET.
    MOVE LDAYS TO MANDAYS (M, L).
    ADD 1 TO L.
    IF L LESS THAN 7 GO TO MANDAYS-LETTERS.
    IF END-OF-SHIP EQUAL TO 1 MOVE 0 TO INOH (M)
        GO TO COMPUTE-AGE.
    IF START-DATE NOT GREATER THAN MONTH (M) MOVE 1 TO INOH (M)
        ELSE MOVE 0 TO INOH (M).
COMPUTE-AGE.
    SUBTRACT COMM-DATE-MONTHS FROM MONTHS-AGE GIVING AGE (M).
    SUBTRACT LOH-DATE-MONTHS FROM MONTHS-AGE GIVING LAST-OH (M).
    ADD 1 TO M.
    ADD 1 TO MONTHS-AGE.
    IF M LESS THAN 25 GO TO CHECK-DATES.
WRITE-RECORD.
    WRITE MASTER-RECORD.
    IF EOF-SWITCH EQUAL TO 1 GO TO END-PROGRAM.
    IF END-OF-SHIP EQUAL TO 1
        MOVE 0 TO END-OF-SHIP
        MOVE SHIP-ID TO SHIP-HOLD
        GO TO CHECK-SHIP.
READ-TO-END.
    READ OVERHAUL-FILE AT END GO TO END-OF-FILE.
```

```
            IF SHIP-ID EQUAL TO SHIP-HOLD GO TO READ-TO-END.
            MOVE SHIP-ID TO SHIP-HOLD.
            GO TO CHECK-SHIP.
        LETTER-OUT.
            IF LETTER EQUAL TO 'A' MOVE '1' TO LETTER GO TO LETTER-EXIT.
            IF LETTER EQUAL TO 'B' MOVE '2' TO LETTER GO TO LETTER-EXIT.
            IF LETTER EQUAL TO 'C' MOVE '3' TO LETTER GO TO LETTER-EXIT.
            IF LETTER EQUAL TO 'D' MOVE '4' TO LETTER GO TO LETTER-EXIT.
            IF LETTER EQUAL TO 'E' MOVE '5' TO LETTER GO TO LETTER-EXIT.
            IF LETTER EQUAL TO 'F' MOVE '6' TO LETTER GO TO LETTER-EXIT.
            IF LETTER EQUAL TO 'G' MOVE '7' TO LETTER GO TO LETTER-EXIT.
            IF LETTER EQUAL TO 'H' MOVE '8' TO LETTER GO TO LETTER-EXIT.
            IF LETTER EQUAL TO 'I' MOVE '9' TO LETTER GO TO LETTER-EXIT.
            MOVE 0 TO LETTER.
        LETTER-EXIT.
            EXIT.
        END-OF-FILE.
            MOVE 1 TO END-OF-SHIP.
            MOVE 1 TO EOF-SWITCH.
            GO TO CHECK-DATES.
        END-PROGRAM.
            CLOSE OVERHAUL-FILE, VALID-SHIP-FILE, MASTER-FILE.
            STOP RUN.
//GO.TAPOUT DD UNIT=2400,DSNAME=MASTER,DISP=(NEW,KEEP),
//             LABEL=(,SL),DCB=(RECFM=F,LRECL=9510,BLKSIZE=9510),
//             VOL=SER=NPS253
//GO.TAPIN DD UNIT=2400,DSNAME=LIPPERT,LABEL=(,SL),
//             VOL=SER=NPS355,DISP=(OLD,KEEP),
//  DCB=(RECFM=FB,LRECL=312,BLKSIZE=3120)
//GO.CARDIN DD *,DCB=BLKSIZE=80
```

APPENDIX H

SECOND PARTIAL MASTER-STEAMING HOURS

```
IDENTIFICATION DIVISION.
PROGRAM-ID. 'MASTR2'.
ENVIRONMENT DIVISION.
CONFIGURATION SECTION.
SOURCE-COMPUTER. IBM-360-67.
OBJECT-COMPUTER. IBM-360-67.
INPUT-OUTPUT SECTION.
FILE-CONTROL.
    SELECT MASTER-FILE ASSIGN TO 'TAPOUT' UTILITY.
    SELECT PARTIAL-MASTER ASSIGN TO 'TAPIN1' UTILITY.
    SELECT STEAMING-FILE ASSIGN TO 'TAPIN2' UTILITY.
DATA DIVISION.
FILE SECTION.
FD  MASTER-FILE
    RECORD CONTAINS 9510 CHARACTERS
    DATA RECORD IS MASTER-RECORD
    RECORDING MODE IS F
    LABEL RECORDS ARE STANDARD.
01  MASTER-RECORD.
    02  SHIP                    PICTURE X(8).
    02  FILLER                  PICTURE X(46).
    02  MONTHLY-INFO OCCURS 24 TIMES.
        03  FILLER              PICTURE X(47).
        03  SH-FC               PICTURE X(22).
        03  INDH                PICTURE 9(1).
        03  FILLER              PICTURE X(324).
FD  PARTIAL-MASTER
    RECORD CONTAINS 9510 CHARACTERS
    DATA RECORD IS PARTIAL-RECORD
    RECORDING MODE IS F
    LABEL RECORDS ARE STANDARD.
01  PARTIAL-RECORD.
    02  PARTIAL-REC             PICTURE X(9510).
FD  STEAMING-FILE
    BLOCK CONTAINS 6 RECORDS
    RECORD CONTAINS 800 CHARACTERS
    DATA RECORD IS STEAMING-RECORD
    RECORDING MODE IS F
    LABEL RECORDS ARE STANDARD.
01  STEAMING-RECORD.
    02  STEAMING-REC OCCURS 10 TIMES PICTURE X(80).
WORKING-STORAGE SECTION.
77  N                           PICTURE 999 VALUE 0.
```

```
77  M                              PICTURE 999 VALUE 0.
01  SH-REC.
    02  FILLER          PICTURE X(2).
    02  SH-SHIP                   PICTURE X(8).
    02  FILLER          PICTURE X(3).
    02  SH-YEAR                   PICTURE 9(2).
    02  FILLER                    PICTURE X(3).
    02  SH-MONTH                  PICTURE 9(2).
    02  FILLER          PICTURE X(9).
    02  SH-SHOUT                  PICTURE 9(3).
    02  FILLER                    PICTURE X(7).
    02  SH-SHIN                   PICTURE 9(3).
    02  FILLER                    PICTURE X(4).
    02  SH-FCOUT                  PICTURE 9(8).
    02  FILLER                    PICTURE X(2).
    02  SH-FCIN                   PICTURE 9(8).
    02  FILLER                    PICTURE X(16).
01  DATE-CHECK.
    02  YEAR-CHECK                PICTURE 9(2).
    02  MONTH-CHECK               PICTURE 9(2).
01  MONTH-DATES.
    02  MONTH-DATE OCCURS 24 TIMES PICTURE X(4).
01  DATES-VALUE.
    02  DATES PICTURE X(96) VALUE '70 77C 87C 97C107C11701271 171
-   ' 271 371 471 571 671 771 871 97110711711272 172 272 372 472
-   ' 572 6'.
01  SH-DATA.
    02  ZC1                       PICTURE 9(3).
    02  ZC2                       PICTURE 9(3).
    02  ZC3                       PICTURE 9(8).
    02  ZC4                       PICTURE 9(8).
01  DATA-HOLD                     PICTURE X(22).
PROCEDURE DIVISION.
    OPEN INPUT STEAMING-FILE PARTIAL-MASTER.
    OPEN OUTPUT MASTER-FILE.
    MOVE DATES TO MONTH-DATES.
    READ STEAMING-FILE AT END GO TO END-OF-SHF.
READ-MASTER.
    READ PARTIAL-MASTER AT END GO TO END-OF-MASTER.
    MOVE PARTIAL-RECORD TO MASTER-RECORD.
    MOVE 1 TO M.
READ-INPUT.
    ADD 1 TO N.
    IF N LESS THAN 11 GO TO PROCESS-INPUT.
    MOVE 1 TO N.
    READ STEAMING-FILE AT END GO TO END-OF-SHF.
PROCESS-INPUT.
    MOVE STEAMING-REC (N) TO SH-REC.
```

```
            IF SH-SHIP LESS THAN SHIP GO TO READ-INPUT.
            IF SH-SHIP GREATER THAN SHIP GO TO NEW-SHIP.
        PROCESS-SHIP.
            MOVE SH-SHIN TO ZC1.
            MOVE SH-SHOUT TO ZC2.
            MOVE SH-FCIN TO ZC3.
            MOVE SH-FCOUT TO ZC4.
            MOVE SH-YEAR TO YEAR-CHECK.
            MOVE SH-MONTH TO MONTH-CHECK.
            IF DATE-CHECK GREATER THAN '70 6' GO TO IN-PERIOD.
            IF SH-DATA NOT EQUAL TO ZERO MOVE SH-DATA TO DATA-HOLD.
            GO TO READ-INPUT.
        IN-PERIOD.
            IF DATE-CHECK GREATER THAN MONTH-DATE (M) GO TO CH-CHECK.
            MOVE SH-DATA TO SH-FC (M) DATA-HOLD.
            ADD 1 TO M.
            IF M LESS THAN 25 GO TO READ-INPUT.
        NEW-SHIP.
            IF M GREATER THAN 24
                WRITE MASTER-RECORD
                GO TO READ-MASTER.
            IF INCH (M) EQUAL TO 1 MOVE ZERO TO SH-FC (M)
                ELSE MOVE DATA-HOLD TO SH-FC (M).
            ADD 1 TO M.
            GO TO NEW-SHIP.
        CH-CHECK.
            IF INCH (M) EQUAL TO 1 MOVE ZERO TO SH-FC (M)
                ELSE MOVE DATA-HOLD TO SH-FC (M).
            ADD 1 TO M.
            GO TO IN-PERIOD.
        END-OF-SHF.
            WRITE MASTER-RECORD.
        END-OF-MASTER.
            CLOSE STEAMING-FILE PARTIAL-MASTER MASTER-FILE.
            STOP RUN.
//GO.TAPIN1 DD UNIT=2400,DSNAME=MASTER,LABEL=(,SL,,IN),
//        VOL=SER=NPS253,DISP=(OLD,KEEP),
//        DCB=(RECFM=F,LRECL=9510,BLKSIZE=9510)
//GO.TAPIN2 DD UNIT=2400,DSNAME=LIPPERT,LABEL=(,SL,,IN),
//        VOL=SER=NPS354,DISP=(OLD,KEEP),
//        DCB=(RECFM=FB,LRECL=800,BLKSIZE=4800)
//GO.TAPOUT DD UNIT=2400,DSNAME=MASTER2,LABEL=(,SL),
//        VOL=SER=NPS125,DISP=(NEW,KEEP),
//        DCB=(RECFM=F,LRECL=9510,BLKSIZE=9510)
```

APPENDIX I

FINAL MASTER PROGRAM

```
IDENTIFICATION DIVISION.
PROGRAM-ID. 'MASTR3'.
ENVIRONMENT DIVISION.
CONFIGURATION SECTION.
SOURCE-COMPUTER. IBM-360-67.
OBJECT-COMPUTER. IBM-360-67.
INPUT-OUTPUT SECTION.
FILE-CONTROL.
    SELECT MASTER-FILE ASSIGN TO 'TAPOUT' UTILITY.
    SELECT PARTIAL-MASTER ASSIGN TO 'TAPIN1' UTILITY.
    SELECT EIC-FILE ASSIGN TO 'TAPIN2' UTILITY.
DATA DIVISION.
FILE SECTION.
FD  MASTER-FILE
    RECORD CONTAINS 9510 CHARACTERS
    DATA RECORD IS MASTER-RECORD
    RECORDING MODE IS F
    LABEL RECORDS ARE STANDARD.
01  MASTER-RECORD.
    02  SHIP                      PICTURE X(8).
    02  FILLER                    PICTURE X(46).
    02  MONTHLY-INFO OCCURS 24 TIMES.
        03  FILLER                PICTURE X(73).
        03  EIC-INFO.
            04  EICS OCCURS 14 TIMES.
                05  APA           PICTURE 9(7).
                05  NSA           PICTURE 9(7).
                05  OTHER         PICTURE 9(7).
            04  APA-TOT           PICTURE 9(9).
            04  NSA-TOT           PICTURE 9(9).
            04  OTHER-TOT         PICTURE 9(9).
FD  PARTIAL-MASTER
    RECORD CONTAINS 9510 CHARACTERS
    DATA RECORD IS PARTIAL-RECORD
    RECORDING MODE IS F
    LABEL RECORDS ARE STANDARD.
01  PARTIAL-RECORD.
    02  PARTIAL-REC PICTURE X(9510).
FD  EIC-FILE
    BLOCK CONTAINS 10 RECORDS
    RECORD CONTAINS 200 CHARACTERS
    DATA RECORD IS EIC-RECORD
    RECORDING MODE IS F
```

```
     LABEL RECORDS ARE STANDARD.
C1   EIC-RECORD.
     02  EIC-SHIP.
         03  FILLER                  PICTURE X(4).
         03  HULL OCCURS 4 TIMES PICTURE X.
     02  FILLER                      PICTURE X(5).
     02  EIC                         PICTURE X(1).
     02  FILLER                      PICTURE X(1).
     02  EC                          PICTURE X(144).
     02  FILLER                      PICTURE X(39).
     02  COG                         PICTURE 9(1).
     02  FILLER                      PICTURE X(1).
WORKING-STORAGE SECTION.
77   L                               PICTURE 999.
77   M                               PICTURE 999.
77   N                               PICTURE 999.
C1   EC-HOLD.
     02  EIC-COSTS OCCURS 24 TIMES.
         03  COSTS                   PICTURE 9(6).
C1   EIC-TABLE.
     02  EIC-GROUPS OCCURS 13 TIMES.
         03  EIC-TABS OCCURS 6 TIMES.
             04  EIC-TAB PICTURE X(1).
C1   INDIVIDUAL-EICS.
     02  I-EICS PICTURE X(78) VALUE '34    5GJ   89    A71Y  BCDEF
-    'KLS    M     N     PR    GF    T     L     W     '.
PROCEDURE DIVISION.
     OPEN INPUT EIC-FILE PARTIAL-MASTER.
     OPEN OUTPUT MASTER-FILE.
     MOVE INDIVIDUAL-EICS TO EIC-TABLE.
READ-MASTER.
     READ PARTIAL-MASTER AT END GO TO END-PROGRAM.
     MOVE PARTIAL-RECORD TO MASTER-RECORD.
READ-EIC.
     READ EIC-FILE AT END GO TO END-EICS.
     MOVE EC TO EC-HOLD.
ZERO-HULL.
     IF HULL (1) EQUAL TO SPACE MOVE ZERO TO HULL (1).
     IF HULL (2) EQUAL TO SPACE MOVE ZERO TO HULL (2).
     IF HULL (3) EQUAL TO SPACE MOVE ZERO TO HULL (3).
     IF EIC-SHIP LESS THAN SHIP GO TO READ-EIC.
     IF EIC-SHIP GREATER THAN SHIP GO TO NEW-SHIP.
     MOVE 1 TO N L M.
PROCESS-EIC.
     IF EIC EQUAL TO EIC-TAB (N, L) GO TO EIC-TYPE1.
     ADD 1 TO L.
     IF L LESS THAN 7 GO TO PROCESS-EIC.
     MOVE 1 TO L.
```

```
            ADD 1 TO N.
            IF N LESS THAN 14 GO TO PROCESS-EIC.
        EIC-TYPE1.
            IF COG NOT EQUAL TO 2 GO TO EIC-TYPE2.
        TYPE1.
            ADD COSTS (M) TO APA (M, N).
            ADD COSTS (M) TO APA-TOT (M).
            ADD 1 TO M.
            IF M GREATER THAN 24 GO TO READ-EIC ELSE GO TO TYPE1.
        EIC-TYPE2.
            IF COG NOT EQUAL TO 1 GO TO EIC-TYPE3.
        TYPE2.
            ADD COSTS (M) TO NSA (M, N).
            ADD COSTS (M) TO NSA-TOT (M).
            ADD 1 TO M.
            IF M GREATER THAN 24 GO TO READ-EIC ELSE GO TO TYPE2.
        EIC-TYPE3.
            ADD COSTS (M) TO OTHER (M, N).
            ADD COSTS (M) TO OTHER-TOT (M).
            ADD 1 TO M.
            IF M GREATER THAN 24 GO TO READ-EIC ELSE GO TO EIC-TYPE3.
        NEW-SHIP.
            WRITE MASTER-RECORD.
            PERFORM READ-MASTER.
            IF EIC-SHIP LESS THAN SHIP GO TO READ-EIC.
            MOVE 1 TO N L M.
            GO TO PROCESS-EIC.
        END-EICS.
            WRITE MASTER-RECORD.
        END-PROGRAM.
            CLOSE MASTER-FILE PARTIAL-MASTER EIC-FILE.
            STOP RUN.
//GO.TAPIN1 DD UNIT=2400,DSNAME=MASTER2,LABEL=(,SL,,IN),
//        VOL=SER=NPS125,DISP=(OLD,KEEP)
//GO.TAPIN2 DD UNIT=2400,DSNAME=LIPPOTH,LABEL=(,SL,,IN),
//        VOL=SER=NPS238,DISP=(OLD,KEEP)
//GO.TAPOUT DD UNIT=2400,DSNAME=MASTER,LABEL=(,SL),
//        VOL=SER=NPS253,DISP=(NEW,KEEP),
//        DCB=(RECFM=F,LRECL=9510,BLKSIZE=9510)
```

APPENDIX J

MATHEMATICS OF PREDICTION INTERVAL COMPUTATIONS

The mathematics involved in the computations of the average monthly repair part consumption prediction intervals is explained in this appendix.

The definitions of the mathematical terms in this appendix are as follows:

1. Y_1, Y_2, Y_3 — The reported repair part consumption for months one, two, and three, respectively, of the three month test period.
2. σ^2 — The variance of a model.
3. S^2 — The unbiased estimate of the variance of a model.
4. Y_* — The average monthly reported repair part consumption for the test period, defined as $\frac{Y_1+Y_2+Y_3}{3}$.
5. w_1', w_2', w_3' — Vectors of observations of the dependent variables of the models for months one, two, and three, respectively, of the three month test period.
6. b — The matrix of coefficients of the models.
7. t — The t-distribution.

The assumptions of this thesis included the assumption of normal distributions of the data of the models. This assumption is utilized in the computations of the prediction intervals. Specifically, it is assumed that the reported monthly repair part consumption for each of the months of

the test period are normally distributed. This assumption implies that the average monthly reported repair part consumption, being the sum of normal distributions, is also normally distributed. Using this assumption and the procedures contained in reference (3) for construction of predicted intervals, the mathematical computation of the prediction intervals was obtained.

The mathematical derivation of the prediction intervals for the average monthly reported repair part consumption is shown below.

1. Y_1 was assumed to be normally distributed with mean $w_1'b$ and variance $\sigma_1^2(1+ w_1'(X'X)^{-1}w_1)$. Y_2 was assumed to be normally distributed with mean $w_2'b$ and variance $\sigma_2^2(1 + w_2'(X'X)^{-1}w_2)$. Y_3 was assumed to be normally distributed with mean $w_3'b$ and variance $\sigma_3^2(1 + w_3'(X'X)^{-1}w_3)$. It was assumed, in the models, that $\sigma_1^2 = \sigma_2^2 = \sigma_3^2 = \sigma^2$.

2. The average monthly reported repair part consumption, defined as $Y_* = \frac{Y_1 + Y_2 + Y_3}{3}$, was therefore distributed normally with mean $\frac{(w_1' + w_2' + w_3')}{3}b$ and variance of

$$\frac{\sigma^2(3 + w_1'(X'X)^{-1}w_1 + w_2'(X'X)^{-1}w_2 + w_3'(X'X)^{-1}w_3)}{9}.$$

3. Then, using probability theory, the ratio

$$\frac{\frac{(w_1' + w_2' + w_3')}{3} - Y_*}{\frac{\sigma}{3}\sqrt{3 + w_1'(X'X)^{-1}w_1 + w_2'(X'X)^{-1}w_2 + w_3'(X'X)^{-1}w_3}}$$

follows a standarized normal distribution. But $\frac{(n-k)s^2}{\sigma^2}$

is distributed as chi-square with (n-k) degrees of freedom, and is independent of the above ratio. Therefore,

$$\frac{\frac{(w_1' + w_2' + w_3')b}{3} - Y_*}{\frac{s}{3}\sqrt{3 + w_1'(X'X)^{-1}w_1 + w_2'(X'X)^{-1}w_2 + w_3'(X'X)^{-1}w_3}}$$

is distributed as the t-distribution with (n-k) degrees of freedom. By using the limits $P(-t_{.975} \leq t(n-k) \leq t_{.975}) = 0.95$, the following 95% prediction interval for Y_* is obtained:

$$\frac{(w_1' + w_2' + w_3')b}{3} - \frac{t_{.975}\, s}{3\sqrt{3 + w_1'(X'X)^{-1}w_1 + w_2'(X'X)^{-1}w_2 + w_3'(X'X)^{-1}w_3}}$$

$$\leq Y_* \leq$$

$$\frac{(w_1' + w_2' + w_3')b}{3} + \frac{t_{.975}\, s}{3\sqrt{3 + w_1'(X'X)^{-1}w_1 + w_2'(X'X)^{-1}w_2 + w_3'(X'X)^{-1}w_3}}.$$

The 95% prediction intervals for the average monthly reported repair part consumption were computed for all models of the thesis utilizing the above derived mathematical formula.

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13. ABSTRACT

An investigation was made of possible linear relationships between several specific factors concerning ships of the Navy and the actual repair part consumption dollar figures for a two year period for the purpose of using such relationships for planning and budgetary aids. Factors considered included steaming hours, fuel consumption, overhaul schedules and overhaul mandays, and ship age. Overall Navy-wide linear models were developed for NSA (odd cog) stock numbered items, for APA (even cog) stock numbered items, for Other (odd cog) manufacturer's part-numbered items (items without a Federal Stock Number assigned), and for a combined overall repair part model. In addition, some of the same models were developed for the Pacific and Atlantic fleets and for certain ship types.

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